

SHELL AVIATION FUELS

Shell Aviation fuels may be classified into three basic groups : aviation gasoline, for use in reciprocating or piston engines; aviation turbine fuels (jet fuels), for use in turbo-fan, turbo-jet and turbo-prop engines and power boost fluids. The various grades of each type available are described in this section.

All Shell Aviation fuels are produced to stringent manufacturing specifications. At every stage between refinery and aircraft tank, fuel quality is checked by sampling and laboratory analysis, 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; a representation matched by no other supplier of aviation fuel.

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 a high 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 (maximum -40°C instead of maximum -47°C) and is available only in North America.

MAJOR CIVIL JET FUEL GRADES

Jet A-1

Jet A-1 is a kerosine grade of fuel suitable for most turbine engaged aircraft. It has a flash point minimum of 38°C (100°F) and a freeze point maximum 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 maximum (-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 covering the 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 only significant demand in very cold climates

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 CIS states. It is a kerosine type fuel with slightly higher volatility (flash point is 28°C minimum) and lower freeze point ($<-50^{\circ}\text{C}$) 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 export 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 used to include Jet B but this grade is now covered by a separate specification ASTM D 6615).

UK JET FUELS

Although developed basically as a military jet fuel, D.Eng RD 2494, issued by the Ministry of Defence, was adopted as the standard UK civil jet fuel. It is now renamed as DEF STAN 91-91 and defines the requirements for a kerosine type fuel (Jet A-1 grade) having a maximum freeze point of -47°C .

Jet A-1 according to the DEF STAN 91-91 specification is very similar to Jet A-1 defined by the ASTM D 1655 except for a small number of areas where DEF STAN 91-91 is more stringent.

FORMER SOVIET UNION 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 members of the 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 Western Jet A-1 and is approved by most aircraft manufacturers.

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 Western 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 basically, as Western Jet A-1, produced as an export grade. RP-4 is a wide-cut type fuel similar to Western 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, 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 - Agip, BP, ChevronTexaco, ExxonMobil, Kuwait Petroleum, Shell, Statoil and TotalFinaElf - as the basis of their international supply of virtually all civil aviation fuels outside North America and former Soviet Union.

OTHER NATIONAL CIVIL JET FUEL SPECIFICATIONS

There are many individual national specifications. Typically, these are based on the US, UK or former Soviet specifications with minor differences. There are increasing moves to harmonise the small differences between the ASTM and DEF STAN specifications. This process of harmonisation is also in progress with many national specifications.

MILITARY JET FUEL GRADES

JP-4

JP-4 used to be the primary jet fuel for the USAF 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-5624T 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-5624T 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-83133E. It is the dominant military jet fuel grade for NATO airforces. The UK also have 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-83133E and is widely used by 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 is 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.

Avgas 100LL

This grade is the low 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.

Avgas 82 UL

This is a relatively new grade 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. This grade is specified in ASTM D 6227.

Avgas 82UL is dyed purple.

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 have been rationalised down to one principle grade, Avgas 100/130. (To avoid confusion and to minimise errors in handling aviation gasoline, it is common practice to designate the grade by just the lean mixture performance, i.e. Avgas 100/130 becomes Avgas 100).

Some years ago, an additional grade was introduced to allow one fuel to be used in engines originally designed for grades with lower 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, i.e. Avgas 100LL is coloured blue, while Avgas 100 is coloured green.

Very recently a new Avgas grade 82 UL (UL standing for unleaded) has been introduced. This is a low octane grade suitable for low compression engines. It has a higher vapour pressure and can be manufactured from motor gasoline components. It is particularly applicable to those aircraft which have STCs to use automotive gasoline.

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 <http://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 <http://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 <http://www.iataonline.com>

AFQRJOS Check List for Jet A-1

The Joint Fuelling Systems Check List for Jet A-1 is maintained by Shell Aviation on behalf of the industry. The latest edition can be accessed on Shell Aviation's website at <http://www.shell.com/aviation>.

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

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 Inc. Report No. 530, titled "Handbook of Aviation Fuel Properties" (CRC Doc. No. 530). This was published in 1983 and is available from the Society of Automotive Engineers, Inc., General Publications Department, 400 Commonwealth Drive, Warrendale, Pennsylvania PA 15096 U.S.A.

Shell AeroJet is a new, 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 problems previously associated with the use of Jet A-1 in business jets, turbo-prop aircraft and helicopters.

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 an anti-icing additive that helps to eliminate this problem and gives added security in case of fuel heater system breakdown.

Anti-Fungal

The formation of water inside a tank creates an environment that allows the growth of bacteria and fungi. Left unchecked this growth can pose a serious danger to plane and passengers. The anti-icing additive in Shell AeroJet acts as a biostat which inhibits the growth of bacteria/fungi and so prevents these dangers occurring. This feature is particularly valuable for aircraft operating in 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.

SHELL POWER BOOST FLUIDS

It used to be commonplace for large piston engines to require special fluids to increase their take-off power. Similar injection systems are also incorporated in some turbo-jet and turbo-prop engines. The power increase is achieved by cooling the air consumed, to raise its density and thereby increase the weight of air available for combustion. This effect can be obtained by using water alone but it is usual to inject a mixture of methanol and water to produce a greater degree of evaporative cooling and also to provide additional fuel energy.

For piston engines, methanol/water mixtures are used and these may have 1 percent of a corrosion inhibiting oil added. The injection system may be used to compensate for the power lost when operating under high temperature and/or high altitude conditions (i.e. with low air densities) or to obtain increased take-off power under normal atmospheric conditions, by permitting higher boost pressure for a short period.

Both water alone and methanol/water mixtures are used in some gas turbine engines, principally to restore the take-off power (or thrust) lost when operating under low air density conditions. Use of a corrosion inhibitor in power boost fluids supplied for these engines is not permitted.

The methanol and water used must be of very high quality to avoid formation of engine deposits. The water must be either demineralised or distilled and the only adulterant permitted in the methanol is up to 0.5 percent of pyridine if required by local regulations as a de-naturant. In the past there were several different grades of water/methanol mixtures, e.g. 45/55/0 for turbine engines, 50/50/0 for piston engines (this was also available with 1% corrosion inhibiting oil and designated 50/50/1) and 60/40/0, however, with decreasing demand Shell now only supplies 45/55/0. The table shows the principal characteristics of Shell demineralised water and of the commonly used methanol/water blend.

Shell Grade Designation	Shell Methanol/Water Mixture 45/55/0 (note 1)	Shell Demineralised Water
Joint Service Designation	AL-28	WTA
Specifications:		
British (Military)	DEF STAN 68-253	DEF STAN 68-253
Rolls-Royce	MSRR 9359	AEP W Issue 2
Pratt & Whitney	CPW 328	
Composition:		
Methanol (BS.506) (note 2)	44 parts by vol.	Nil
Pure Water	56 parts by vol.	100%
Corrosion inhibiting oil	Nil	Nil
Properties:		
Appearance	Clear, colourless	Clear, colourless
Density @ 15°C (kg/l)	0.941 to 0.945	1.000
Residue on evaporation (ppm)	10 max	10 max
Principal application	R-R Dart turbo-prop engines	Some R-R Spey and early P & W JT-9D engines

Notes:

1. Sometimes also referred to in specifications as Methanol/Water 44/56 grade
2. Up to 0.5% pyridine permitted as a de-naturant in BS.506

AeroShell Performance Additive 101, developed for the USAF JP-8 +100 programme by BetzDearborn (now GE Betz) for high temperature, high performance jet fuel, helps improve engine reliability while reducing overall operating and maintenance costs.

AeroShell Performance Additive 101 is a unique, patented jet fuel additive designed to improve the thermal stability of military jet fuels. An extensive testing programme has demonstrated engine performance improvements and substantial cost savings.

AeroShell Performance Additive 101 is the only product to meet the goals of the U.S. Air Force JP-8 +100 Project. It has over three million flight hours in operation at USAF and ANG locations and is now available to non-U.S. military customers.

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.

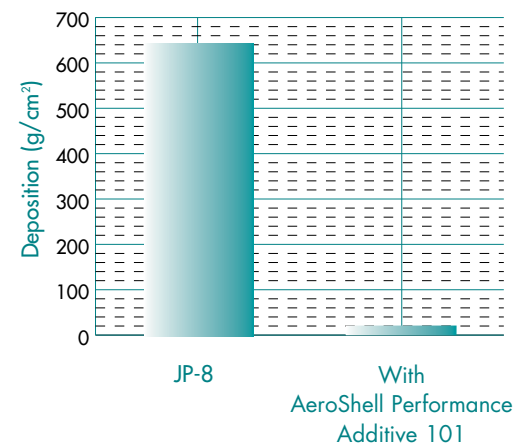
AeroShell Performance Additive 101 is designed to:

- 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.
- reduce smoke signature.

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 BetzDearborn (now GE Betz), 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



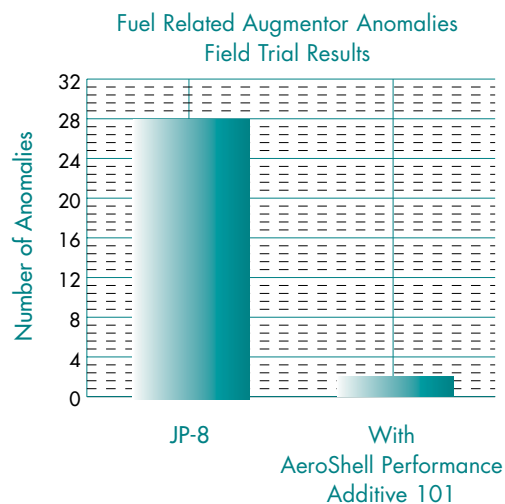
Reduces Fuel Manifold & Nozzle Coking

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.

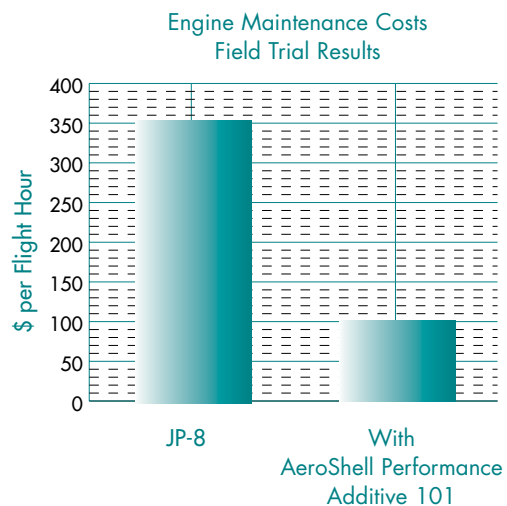
Reduces Unscheduled Engine Removals

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 and consequently lowered the cost of engine removals by as much as 50%*.



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.



Improved Flight Safety

Afterburner (reheat) malfunctions are dangerous and can place pilots and their equipment in jeopardy. Failures to ignite afterburner spray fuel rings can cause mechanical damage, place pilots at risk, and in combat, potentially mean the split-second difference between life and death.

AeroShell Performance Additive 101 has been field tested in a wide range of high performance jet engines as part of the USAF JP-8 +100 Programme and has shown that it significantly reduces these malfunctions - by as much as 80%*.

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 by as much as 70% per flight hour*.

Combine this with improved aircraft readiness, and the full benefit of AeroShell Performance Additive 101 can add up to a first-class return on 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

Summary of Benefits

- Improved Jet Fuel Thermal Stability
- Cleaner Engines and Components
- Reduced Operational Costs
- Fewer Engine Removals
- Lower Abort Rates
- Lower Maintenance Costs
- Improved Air Readiness
- Improved Flight Safety

*Based on data collected on the following engine types: F100-PW-100, F100-PW-200 Series, J85-GE-5, J69-T-25
Additional field tested engine types include: F110-GE-100, TF34-GE-100, T56-A-15

Non-Military Usage of AeroShell Performance Additive 101

Although the development of AeroShell Performance Additive 101 was the result of a requirement in military aircraft, benefits could also be achievable in commercial aviation. However, engine overhaul lives in civil aviation are an order of magnitude greater than those of military aircraft; consequently it is unrealistic to expect the same dramatic reductions in maintenance costs. What other benefits might be achievable?

By keeping fuel and combustion systems clean, optimum combustion conditions should be maintained for longer and this should have a beneficial effect on the normal performance deterioration rate seen during service. This could be translated into an improvement in specific fuel consumption, but any improvement is likely to be small and difficult to measure. Even so, an improvement of only 0.2%, say, in specific fuel consumption can still have a significant effect on an airline's fuel bill. Such benefits can only be quantified by prolonged flight trials and Shell Aviation is currently working with several airlines to generate these data.

Another benefit of AeroShell Performance Additive 101 has already been demonstrated in a number of combustor rig trials, where it was seen to actively reduce particulates and heavy unburned hydrocarbons in the exhaust emissions. Further rig and engine testing is planned to quantify the emissions reduction capability of AeroShell Performance Additive 101.

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 5ml 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.