

**AVIATION FUEL QUALITY REQUIREMENTS FOR
JOINTLY OPERATED SYSTEMS
(AFQRJOS)**

This document has the agreement of: BP, ChevronTexaco, ENI, ExxonMobil, Kuwait Petroleum, Shell, Statoil, and Total. It defines the fuel quality requirements for supply into Jointly Operated Fuelling Systems.

The Aviation Fuel Quality Requirements for Jointly Operated Systems (AFQRJOS) for Jet A-1 embodies the most stringent requirements of the following two specifications:

- (a) British Ministry of Defence Standard DEF STAN 91-91/Issue 5 of 8 February, 2005 and Amendment 2, dated 9 March 2007, for Turbine Fuel, Aviation Kerosene Type, Jet A-1, NATO Code F-35, Joint Service Designation AVTUR.
- (b) ASTM Standard Specification D 1655 – 06d for Aviation Turbine Fuels "Jet A-1."

Jet fuel that meets the AFQRJOS is usually referred to as "Jet A-1 to Check List", or "Check List Jet A-1" and, by definition, generally, meets the requirements of both of the above specifications.

The main table requirements in IATA Guidance Material for Aviation Turbine Fuels Specifications (GM) are no longer part of the Check List because Part I of the IATA GM is now a guide to specifications rather than a specification itself. However, the water and dirt limits for fuel at the point of delivery into aircraft, which are embodied in Part III of the IATA GM, remain part of Check List.

The Aviation Fuel Quality Requirements for Jointly Operated Systems for Jet A-1 are defined in the following table that should be read in conjunction with the notes on pages 3 to 5 of this document. The notes highlight some of the main issues concerning the specification parameters.

In principle, conformance to AFQRJOS requires conformance to the detail of both specifications listed above, not just the following table. However, the JIG Product Quality Committee that publishes the Check List has decided to allow inclusion of some test methods that are not common to both parent specifications.

The reasons are that (1) there are some significant differences between the allowed test methods in DEF STAN 91/91 and ASTM D 1655, (2) there are variations in the availability of test equipment in different parts of the world and, (3) there is a desire to promote the adoption of more modern test methods.

Therefore product tested using the test methods listed here meets the requirements for aviation fuel supply into Jointly Operated Systems. It does not necessarily meet the detailed test method requirements of both parent specifications. See Note 21 for guidance on statements declaring conformance to these specifications.

Also, it should be specifically noted that DEF STAN 91-91/5 requires traceability of product to point of manufacture.

JOINT FUELLING SYSTEM CHECK LIST FOR JET A-1

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Embodying the most stringent requirements in the following specifications for the grade shown:

(a) British MoD DEF STAN 91-91/Issue 5, dated 8 February 2005, and Amendment 2 dated 9 March 2007, Jet A-1.

(b) ASTM D 1655 – 06d, Jet A-1.

PROPERTY	LIMITS	TEST METHOD		REMARKS
		IP	ASTM	
APPEARANCE Visual	Clear, bright and visually free from solid matter and undissolved water at ambient temperature			
Colour	Report		D 156 or D 6045	See note 1
Particulate contamination, mg/L	max 1.0	423	D 5452	See note 2
COMPOSITION				See note 3
Total Acidity, mg KOH/g	max 0.015	354	D 3242	
Aromatics, % vol.	max 25.0	156	D 1319	
OR Total Aromatics, % vol	max 26.5	436	D 6379	See note 4
Sulphur, Total, % mass	max 0.30	336	D 1266 or D 2622	or D 4294 or D 5453
Sulphur, Mercaptan, % mass	max 0.0030	342	D 3227	
OR Doctor Test	Negative	30	D 4952	See note 5
Hydroprocessed components in batch, % vol.	Report (incl. 'nil' or '100%')			See note 6
Severely hydroprocessed components, % vol.	Report (incl. 'nil' or '100%')			See note 6
VOLATILITY				
Distillation	Report	123	D 86	See note 7
Initial Boiling Point, °C				Or IP 406 or D 2887, see note 8
Fuel Recovered				
10% vol. at °C	max 205.0			
50% vol. at °C	Report			
90% vol. at °C	Report 300.0			
End Point, °C	max 1.5			
Residue, % vol.	max 1.5			
Loss, % vol.	max 38.0			
Flash Point, °C	min 775.0 min to 840.0 max	170 or 523	D 56 or D 3828	See note 9
Density at 15°C, kg/m³		160 or 365	D 1298 or D 4052	
FLUIDITY				
Freezing Point, °C	max - 47.0	16 or 435 or 528 or 529	D 2386 or D 5972 or D 7153 or D 7154	See note 10
Viscosity at -20°C, cSt (mm²/s)	max 8.000	71	D 445	
COMBUSTION				
Specific Energy, net, MJ/kg	min 42.80		D 3338 or D 4809	See note 11.
Smoke Point, mm	min 25.0	57	D 1322	
OR				
Smoke Point, mm	min 19.0	57	D 1322	
AND Naphthalenes, % vol.	max 3.00		D 1840	
CORROSION				
Corrosion, Copper strip, classification (2 hours +/- 5 min. at 100 °C +/- 1°C)	max 1	154	D 130	
STABILITY				
Thermal Stability (JFTOT)		323	D 3241	See note 12
Control temperature, °C	min 260			
Filter Pressure Differential, mm Hg	max 25.0			
Tube Deposit Rating (Visual)	Less than 3, no 'Peacock' or 'Abnormal' colour deposits			
CONTAMINANTS				
Existent Gum, mg/100ml	max 7	540	D 381	
Microseparometer (MSEP), rating			D 3948	See note 13
Fuel with Static Dissipator Additive	min 70			
OR				
Fuel without Static Dissipator Additive	min 85			
CONDUCTIVITY				
Electrical Conductivity, pS/m	50 min to 600 max	274	D 2624	See note 14
LUBRICITY				
BOCLE wear scar diameter, mm	max 0.85		D 5001	See note 15

ADDITIVES (Names and approval code from DEF-STAN 91-91/5 should be quoted on quality certificates).			
Antioxidant , mg/l in hydroprocessed & synthetic fuels (Mandatory) in non-hydroprocessed fuels (Optional)	max	17.0 min to 24.0 max 24.0	See note 16
Metal Deactivator , mg/l (Optional)	max	5.7	See note 17
Static Dissipator , mg/l First Doping Re-doping	Stadis® 450 max	3.0	See note 18
Antioxidants are mandatory in hydroprocessed fuels and synthetic fuels and must be added immediately after hydroprocessing or synthesising and prior to the product or component being passed into storage in order to prevent peroxidation and gum formation after manufacture.		The types and concentrations of all additives used are to be shown on refinery Certificates of Quality and other quality documents.	
Fuel System Icing Inhibitor is not permitted unless agreed by all the participants in a joint system (see also note 19).		See note 20 about requirements for management of change in refineries.	
Corrosion Inhibitor/Lubricity Improver (CI/LI) additive may be added to the fuel without prior consent of the joint system participants (see also Note 15).			

Main Table Notes

1. The requirement to report Saybolt Colour shall apply at point of manufacture, thus enabling a colour change in distribution to be quantified. Where the colour of the fuel precludes the use of the Saybolt Colour test method, then the visual colour shall be reported. Unusual or atypical colours should also be noted and investigated. For further information on the significance of colour see Annex E in DEF STAN 91-91/5.
2. This limit shall apply at point of manufacture only. For more information on particulate contamination refer to Annex F of DEF STAN 91-91 Issue 5. For guidance on contamination limits for into-plane fuelling refer to 5th Edition IATA Guidance Material (Part III).
3. Attention is drawn to DEF STAN 91-91 Issue 5 which approves the Semi-Synthetic Jet Fuel (SSJF) produced by SASOL under approval reference FS(Air)ssjet/1. For SSJF additional testing requirements apply and reference should be made to Issue 5 of DEF STAN 91-91. This particular semi-synthetic fuel meets the requirements of this Issue of Check List.
4. Testing for Total Aromatics has been introduced into DEF STAN 91-91. It is included in Check List to promote the adoption of more modern test methods. The DEF STAN note reads: "Round robin testing has demonstrated the correlation between total aromatics content measured by IP 156/ASTM D 1319 and IP 436/ASTM D 6379. Bias between the two methods necessitates different equivalence limits as shown. Testing laboratories are encouraged to measure and report total aromatics content by the two methods to assist verification of the correlation. In cases of dispute IP 156 will be the referee method".
5. The Doctor Test is an alternative requirement to the Sulphur Mercaptan Content. In the event of conflict between the Sulphur Mercaptan and Doctor Test results, the Sulphur Mercaptan result shall prevail.
6. The need to report the % vol. of hydroprocessed and severely hydroprocessed components (including "nil" or "100%" as appropriate) on refinery Certificates of Quality for Jet A-1 to Check List derives from DEF STAN 91-91/5. It relates to:
 - (a) antioxidant additives - additive dose rate cannot be interpreted unless the proportion of hydroprocessed fuel is known and therefore recipients of Jet A-1 cannot check or demonstrate that fuel complies with Check List if this information is omitted from refinery Certificates of Quality,

- (b) the requirement to report the volume % of severely hydroprocessed components as part of the lubricity requirement in DEF STAN 91-91/5. Note that "hydroprocessed" includes hydrotreated, hydrofined and hydrocracked. Severely hydroprocessed components are defined as petroleum derived hydrocarbons that have been subjected to hydrogen partial pressure of greater than 7000 kPa (70 bar or 1015 psi) during manufacture.
7. In methods IP 123 and ASTM D 86 all fuels certified to this specification shall be classed as group 4, with a condenser temperature of zero to 4°C.
 8. There are different requirements for the use of IP 406 or D 2887 as an alternate method between ASTM D 1655-06 and DEF STAN 91-91/5. ASTM allows the use of simulated distillation results directly with different limits, while DEF STAN requires a conversion of simulated distillation results to estimated IP 123 results using Annex G of IP 406. These different approaches were taken because of operational considerations rather than technical considerations; there is no intent that one approach is more restrictive than the other. If IP 406 is the method used to generate IP123 extrapolated data, there is no requirement to report residue or loss. IP 123 extrapolated data may also be used for the calculation of Specific Energy using ASTM D 3338.
 9. Subject to a minimum of 40°C, results obtained by method ASTM D 56 (Tag) may be accepted.
 10. These automatic methods are allowed by DEF STAN 91-91/5. IP 16/ASTM D 2386 remains the referee method.
 11. ASTM D 4529/IP 381 may be used where local regulations permit.
 12. Examination of the heater tube to determine the Visual Tube Rating using the Visual Tuberator shall be carried out within 120 minutes of completion of the test. It is the Visual Tube Rating that should be reported. Attention is drawn to Note 10 in DEF STAN 91-91/5, which stresses that only approved heater tubes shall be used and lists JFTOT tubes from PAC-Alcor as being technically suitable.
 13. Attention is drawn to Note 13 of DEF STAN 91-91/5 that states "No precision data are available for fuels containing SDA; if MSEP testing is carried out during downstream distribution, no specification limits apply and the results are not to be used as the sole reason for rejection of a fuel".
 14. Due to the requirements of DEF STAN 91-91/5, Conductivity limits are mandatory for product to meet this specification. However it is acknowledged that in some manufacturing and distribution systems it is more practical to inject SDA further downstream. In such cases the Certificate of Quality for the batch should be annotated thus: "Product meets the requirements of AFQRJOS Check List 22 except for electrical conductivity". Due to the high flow rates and very fine filtration used when fuelling aircraft, it is absolutely essential that these conductivity limits are met at the point of delivery to aircraft.
 15. This requirement comes from DEF STAN 91-91/5. The requirement to determine lubricity applies only to fuels containing more than 95% hydroprocessed material and where at least 20% is severely hydroprocessed (see NOTE 6 above) and for all fuels containing synthetic components. The limit applies only at the point of manufacture. For important advisory information on the lubricity of aviation turbine fuels see Annex B of DEF STAN 91-91/5. CI/LI additive may be used to improve lubricity; only those additives listed in Table 2 of ASTM D1655-06d are permitted. Refer also to Appendix A.4 of DEF STAN 91-91/5 Am2 for advice on point of addition. When injecting CI/LI downstream of point of manufacture, care must be taken to ensure that maximum dose rates are not exceeded.

16. Approved antioxidant additives are listed in Annex A.1.4 of DEF STAN 91-91/5, together with the appropriate RDE/A/XXX- Qualification Reference for quoting on refinery Certificates of Quality.
17. The approved Metal Deactivator Additive (MDA), RDE/A/650 appears in Annex A.2.2 of DEF STAN 91-91/5. See also Annex A.2.1 about the need to report thermal stability before and after using when contamination of Jet A-1 by any of the trace metals listed in this Annex is unproven. Note also in A.2.3 that maximum doping at the point of manufacture or on initial doping is limited to 2mg/l.
18. Re-doping limits for Static Dissipator additive are:
- | | | |
|----------------------------|-------------------------|----------|
| Cumulative concentration | Stadis® 450 (RDE/A/621) | 5.0 mg/l |
| Original dosage not known: | | |
| Additional concentration | Stadis® 450 (RDE/A/621) | 2.0 mg/l |
19. Concentrations of Fuel System Icing Inhibitor (FSII) less than 0.02% by volume can be considered negligible and do not require agreement/notification. The assent to allow these small quantities of FSII without agreement/notification is to facilitate the changeover from fuels containing FSII to those not containing FSII where the additive may remain in the fuel system for a limited time. This does not allow the continuous FSII addition at these low concentrations.
20. Attention is drawn to the guidance in DEF STAN 91-91 Issue 5 and ASTM D 1655-06d concerning the need for appropriate management of change measures in refineries manufacturing jet fuel. The implications of any changes to feedstock, processing conditions or process additives on finished product quality and performance need to be considered (for example, experience has shown that some process additives might be carried over in trace quantities into aviation fuels).
21. It is normal to certify conformance to specifications with statements like "It is certified that the samples have been tested using the Test Methods stated and that the Batch represented by the samples conforms to AFQRJOS Checklist Issue 22. Where applicable, Batch Certificates may also confirm, specifically, compliance with DEF STAN 91-91 (latest issue) and/or ASTM D 1655 (latest issue).

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