



JET A1

ANCAP specifications are updated in accordance with "Check List Jet A-1" of AFQRJOS Issue 35- August 2024.

<i>TESTS</i>	<i>SPECIFICATIONS</i>	<i>REFERENCE METHOD</i>
APPEARANCE		
Visual appearance (1)	Clear, bright, and visually free from solid matter and undissolved water at ambient fuel temperature	
Colour (2)	Report	ASTM D156 / ASTM D6045
Particulate Contamination, mg/L (3) o	Max. 1.0	ASTM D5452 / IP 423
Particulate, cumulative channel particle counts. ISO Code & Individual Channel Count (3), (4)	Channel counts / ISO Code	IP 565 / IP 577 / ASTM D7619
≥ 4 µm (c)	Report / Max. 19	
≥ 6 µm (c)	Report / Max. 17	
≥ 14 µm (c)	Report / Max. 14	
≥ 21 µm (c)	Report	
≥ 25 µm (c)	Report	
≥ 30 µm (c)	Report / Max. 13	
COMPOSITION		
Total acidity, mg KOH/g	Max. 0.015	ASTM D3242 / IP 354
Aromatics, % in volume or	Max. 25.0	ASTM D1319 / IP 156
Total aromatics, % in volume (8)	Max. 26.5	ASTM D6379 / IP 436
Sulphur, mass %	Max. 0.30	ASTM D2622 / ASTM D4294 / ASTM D5453 / ASTM 1266 / IP 336
Sulphur mercaptan, mass % or	Max. 0.0030	ASTM D3227 / IP 342
Doctor Test (9)	Negative	ASTM D4952 / IP30
Refining Components at point of manufacture:		
Non Hydroprocessed Components, %in volume (5)	Report (inclusive "0" or "100%")	
Severely Hydroprocessed Components, % in volume (5)	Report (inclusive "0" or "100%")	

Synthetic Components, % in volume (5, 6, 7)	Report (inclusive "0" or "50%")	
Co-processed Components, % in volumen	Max. 10	ASTM D 1655
INCIDENTAL MATERIALS		
See Note (10)		
TESTS	SPECIFICATIONS	REFERENCE METHOD
VOLATILITY		
Distillation (11) (12)		ASTM D86 / ASTM D7345 / IP 123 (11)
Initial Boiling Point, °C	Report	
10% Recovery, °C	Max. 205.0	
50% Recovery, °C	Report	
90% Recovery, °C	Report	
End point, °C	Max. 300.0	
Residue, %in volume	Max. 1.5	
Loss, %in volume	Max. 1.5	
Flash Point, °C	Min. 38.0	ASTM D56 / ASTM D3828 / IP 170 / IP 523 / ASTM D93 (proc. A)
Density at 15°C, kg/m ³	775.0 Mn. to 840.0 Max.	ASTM D4052/IP 365/IP 160/ASTM D 1298
FLUIDITY		
Freezing Point, °C (13), (14)	Max. -47.0	ASTM D2386 / ASTM D7153/ASTM D 5972/IP 16/IP 435/IP 529/ASTM D 7154/IP 528
Viscosity at -20°C, cSt (15)	Max. 8.000	ASTM D 445/IP 71/ASTM D 7042/ASTM D 7945
COMBUSTION		
Specific Energy, net, MJ/kg (16)	Min. 42.80	ASTM D3338 / ASTM D4809 / IP 12
Smoke Point, mm (17) or	Min. 25.0	ASTM D1322 / IP 598
Smoke Point, mm (17) And	Min. 18.0	ASTM D1322 / IP 598
Naphthalenes, % in volume	Max. 3.00	ASTM D1840
CORROSION		
Corrosion, Copper strip (2 hours +/- 5 min. at 100 °C +/- 1°C)	Max. 1	ASTM D130 / IP 154

TESTS	SPECIFICATIONS	REFERENCE METHOD
STABILITY		
Thermal Stability (JFTOT) Control temperature, °C (18)	Min. 260	ASTM D3241 / IP 323
Filter Pressure Differential, mmHg	Max. 25.0	
Tube rating: One of the following requirements shall be met:		
Annex A1 (VTR) or:	Less than 3 No "Peacock" or "Abnormal" colour deposits	
Annex 2 ITR or Annex 3 ETR or Annex A4 MWETR, average over area of 2.5 mm ² (nm)	Max. 85 nm	
CONTAMINANTS		
Existent Gum, mg/100 ml	Max. 7	ASTM D381 / IP 540
Water Separation Characteristics (19)		
With Stadis 450	Min. 70	ASTM D3948
Without Stadis 450	Min. 85	
With or Without Stadis 450	Min. 88	ASTM D8073
CONDUCTIVITY (20)		
Electrical Conductivity, pS/m	50 Min. to 600 Max.	ASTM D2624 / IP 274
LUBRICITY (21)		
BOCLE wear scar diameter, mm	Max. 0.85	ASTM D5001
ADDITIVES		
<p>The types and concentrations of all additives used shall be shown on the original Certificates of Quality and on all other quality documents when they are added downstream of the point of manufacture.</p> <p>Names and qualification reference from DEF STAN 91-091/18 should be quoted on quality certificates.</p> <p>When additives are diluted (with hydrocarbon solvent only) to improve handling properties prior to addition, it is the concentration of active ingredient that shall be reported. See Annex A of DEF STAN 91-091 for detailed advice.</p> <p>Attention should be paid to change management at the point of manufacture for both jet fuel and its components, in accordance with DEF-STAN 91-091/18 and ASTM D1655, latest edition. The implications of any changes in feedstock, process conditions, or additives used should be considered in relation to the final product's quality and performance (for example, experience has shown that some process additives may reach aviation fuel in trace amounts).</p> <p>When the original dosage of additives is unknown, it has to be assumed that first doping was applied at maximum dose rate.</p>		

TESTS	SPECIFICATIONS	REFERENCE METHOD
Antioxidant (AO), mg/L (22)		
In final batch, in fuels manufactured from petroleum sources (Optional). In hydroprocessed & synthetic fuels (Mandatory)	Max. 24.0	
Metal Deactivator Additive (MDA), optional, mg/L (23)		
On initial blending	Max. 2.0	
After field reblending cumulative concentration	Max. 5.7	
Static Dissipator Additive (SDA), mg/L (24)		
On initial blending	Max. 3.0	IP568 / ASTM D7524
After field reblending cumulative concentration	Max. 5.0	
Lubricity Improver Additive (LIA) (21), (25)		
Fuel System Icing Inhibitor (FSII) (26)		
Additive Mixtures (27)		
Leak Detection Additive (28)		

NOTES

- (1) The Visual Appearance method in DEF STAN 91-091/18 is Visual. Alternative methods are ASTM D4176 Procedure 1 and ASTM D6986 Procedure A, Section 8.1.1.1.
- (2) The requirement to report the Saybolt Colour applies to the point of manufacture. Unusual or atypical colours must be reported and investigated. For further information on the significance of colour test, see Annex F in DEF STAN 91-091/18.
- (3) This limit applies only at the point of manufacture. Either the particulate contamination limit or the particle count limit must be met, and it is only necessary to reported whichever property is being used to support fuel release. The Specification Authority intends to replace gravimetric testing using membrane filtration with particle counting, effective April 2025. For further information on the meaning of the particulate contamination test, see Annex F in DEF STAN 91-091/18. For guidance on contamination limits for aircraft fueling, refer to the 9th Edition of the IATA Guidance Material (Part III).
- (4) The particle number, and the particle number from the numerical scale defined in Table 1 of ISO 4406, must be reported when using this method to release the fuel (see also Note 3). If the limits are exceeded, Annex B of IP 565 or IP 577 or Annex A2 of D7619 may be applied to remove traces of free water and redetermine cleanliness. In such cases, the results before and after application of the annex must be reported.

- (5) The requirement to report %v/v of non-hydroprocessed, severely hydroprocessed, and synthetic components (including “nil”, “50%”, or “100%” as applicable) on the Point of Manufacturing Quality Certificate for Jet A-1 derives from DEF STAN 91-091/18. Each of the defined component used in the batch must be reported on the Quality Certificate as a percentage by volume of the total batch. See Note 21.
- (6) Attention is drawn to DEF STAN 91-091/18, which approves Semi-Synthetic and Fully Synthetic Jet fuels produced by SASOL. All generic components listed in the Annexes of ASTM D7566 are also approved. For these fuels, additional testing requirements apply, and reference should be made to DEF STAN 91-091/18 Annex B.
- (7) The semi-synthetic jet fuel CoQ at point of batch origination shall include a listing of the quality documents relating to the conventional and synthetic blend component (SBC) batches in the blend and their respective volumes to show compliance with the blending limits set out in the Annexes to ASTM D7566. The SBC producer’s CoQ, CoA or RT number shall be available for each SBC at the point of batch origination including number, antioxidant concentration (as the concentration of active material reported on originator’s CoQ) and corresponding formulation Qualification reference per Annex A.2.4. The use of antioxidant is optional for fuels manufactured from petroleum sources. Antioxidant continues to be mandatory as part of the production process for synthetic component (see ASTM D7566 or Annex B.2 of Def STAN 91-091/18).
- (8) Inter laboratory studies have demonstrated the correlation between total aromatics content measured by IP 156/ASTM D1319 and IP 436/ASTM D6379. Bias between the two methods necessitates different equivalence limits as shown. In cases of dispute IP 156/ASTM D 1319 will be the referee method. It is the intention of the Technical Authority of DEF STAN 91-091 to change the referee method to IP 436 at a later date.

Due to technical problems, proprietary dyes with lot numbers 3000000975 through and including 3000000982 are unacceptable for use when conducting IP 156/ASTM D1319 and should not be used in conjunction with these test methods.

When it is necessary to determine the aromatic level, Jet A-1 fuel will only meet the aviation fuel operating limitations of airplanes certified to operate on Jet A-1 fuel and the requirements of Def Stan 91-091 if:

- 1) the fuel has been tested for aromatic concentration in accordance with ASTM D1319/IP156 with a dye other than from lot number 3000000975 to 3000000982
- or
- 2) the fuel has been tested for aromatic concentration in accordance with alternative test methods ASTM D6379/IP436.

No other alternative test method or method for deriving aromatic content is acceptable.

- (9) The Doctor Reaction is an alternative requirement to the Sulfur Mercaptan content. However, if the Doctor Reaction is positive, the Sulfur Mercaptan test shall be carried out and reported. In the event of a conflict between Sulfur Mercaptan and Doctor Reaction tests results, the Sulfur Mercaptan test result shall prevail.

(10) Contaminant Materials

Material	Maximum permitted level	Detection level	Test methods
Fatty acid methyl ester (FAME) a, b, c	50 mg/kg		ASTM D 7797/IP 585 ^d . IP 590. IP 599
Pipeline Drag Reducer (DRA) ^a	Nil	72 µg/L (e,f)	ASTM D 7872

a) After manufacturing, each custodian shall undertake a risk assessment to quantify the potential risk of contaminant material transfer. When such assessments indicate a potential risk in jet fuel supplies, additional quality assurance procedures will be introduced to enhance control and mitigate the risk. When there is a risk of transfer of contaminating material that cannot be controlled with additional quality assurance procedures, analyses will be initiated.

b) For the purpose of meeting this requirement, FAME is defined as material that meets EN 14214 or ASTM D6751. Fatty acid methyl esters that do not meet biodiesel standards are not permitted in jet fuel.

c) In an emergency, up to 100 mg/kg of FAME may be permitted in jet fuel, when authorized by the aircraft airframe and engine manufacturers, in accordance with airframe and engine requirements. For military purposes, an emergency can be defined as an unexpected or unforeseen situation that requires rapid action. For example, the introduction of FAME contamination into a portion of an airport's distribution system cannot be quickly remediated without halting fueling operations. All such instances must be escalated to the appropriate airport authorities. For commercial operators, refer to SAIB NE-09-25R2 dated May 19, 2016, which provides corrective actions and procedures to be followed in cases of FAME contamination.

d) Method IP 585 is the reference method.

e) DRA is not an approved additive for jet fuel at any concentration. Dilution of fuel with known amounts of DRA is not permitted, even at levels below the level indicated in Table 2. Where the DRA level is otherwise unknown, a result at or below the level in Table 2 would support an assumption of zero addition.

f) The DRA level at the point of manufacture not need be reported. However, DRA content testing is required as part of a Risk Assessment when DRA is or must be added into other products in a multi-product pipeline system that also transports jet fuel.

(11) In methods IP 123 and ASTM D86, all fuels certified to DEF STAN 91-091/18 or ASTM D1655 (latest edition) must be classified as Group 4, with the condenser temperature between 0 and 4°C. If ASTM D7345 is used, the results must be corrected for relative bias as described in the method.

(12) If IP 406 or ASTM D2887 are used to generate data equivalent to IP 123 or data correlated to ASTM D86, the residue and losses should be reported as "not applicable" (NA).

(13) These automated methods are acceptable; IP 16/ASTM D2386 remains the reference method.

(14) If the freezing point is too low to be reported in downstream distribution by method IP16, the limit is a maximum of -65°C. If no crystals appear during fuel cooling when the thermometer indicates -65°C, it shall be reported as <-65°C. This limit does not apply when the freezing point is measured by methods IP 435/ASTM D5972, IP 529, ASTM D7153, IP528, or ASTM D7154.

(15) Results obtained using ASTM D7042 must be converted to bias-corrected kinematic viscosity results as described in the Precision and Bias section of ASTM D7042.

- (16) ASTM D4529/IP 381 may be used where local regulations permit.
- (17) The IP 598 Smoke Point test includes both manual and automated methods, with the automated method being the reference method.
- (18) The annexes referenced in Table 1 and in this note correspond to ASTM D3241 (equivalent to IP323), where the rod evaluation method can be visual (VTR), interferometric (ITR), or ellipsometric (ETR). Deposits on the rod must be measured by ASTM D3241 (or IP323) Annex A2 ITR, or Annex A3 ETR, when available. If the Annex A2 ITR device reports "N/A" for a measurement, the test must be considered failed and report > 85 nm. Visual evaluation of the rod by ASTM D3241 Annex A1 is not required when reporting deposit thickness according to Annex A2 ITR or Annex A3 ETR. In case of dispute between the results of the visual method and a metrological method, the metrological method will be considered the reference. The rod examination to determine the visual deposit using the Visual Tube Rater or the deposit thickness using ETR or ITR must be performed within 120 minutes of the test.
- (19) Water separation property is a mandatory requirement only at the point of manufacture. In ASTM D1655, the only approved method is ASTM D3948. However, Def Stan 91-091/18 lists ASTM D8073 as an alternative, with a Minimum limit of 88. Note that none of the primary standards require water separation testing downstream of the point of manufacture. Where required by JIG standards for product quality management purposes, the following methods and limits apply:

Analysis Method	Limits
ASTM D7224	85 Min.
ASTM D8073	88 Min.

Alternatively, testing may be performed using ASTM D3948 (despite JIG's intention to withdraw this method in the future). For more information on water separation testing, refer to JIG Bulletins 129, 142, and 150, "Testing of Water Separation Properties in Jet Fuel (Revised MSEP Protocol)."

This protocol is also referenced in Note 18 of DEF STAN 91-091/18.

- (20) Conductivity limits are mandatory for the product to meet the specification, as per the requirements of DEF STAN 91-091/18. However, it is acknowledge that in some processing and distribution systems it is more practical to inject Antistatic Additive (SDA) downstream. (See note 24). In such cases, the Certificate of Quality for the batch should state: "The product meets the requirements of DEF STAN 91-091/18, with the exception of electrical conductivity." In some cases, the conductivity may drop rapidly and the fuel may not respond to further addition of SDA. In such cases, the fuel may be released with a minimum conductivity of 25 pS/m provided it has been fully checked against the specification and the appropriate Tank Release Note is annotate with the following explanation: "Product released below 50 pS/m due to loss of conductivity, according to ANNEX F.2 of DEF STAN 91-091/18." For further information, see JIG 2, 4.8 (Protocol for Low Conductivity Fuel)
- (21) The requirement to determine lubricity applies only to fuels that contain: a) less than 5% non-hydroprocessed components and at least 20% severely hydroprocessed components, or b) include synthetic components (See Note 6).
 The limit applies only at the point of manufacture. For important recommendations on the lubricity of aviation turbine fuels, see Annex F of DEF STAN 91-091/18.
 A lubricity improver additive (LIA) may be used to improve lubricity. It may be added to the fuel without prior consent of the joint system participants. However, only the additives listed in Table 2 of ASTM D1655 / Annex A of DEF STAN 91-091/18 are permitted. For recommendations regarding the point of addition, refer to Appendix A5 of DEF STAN 91-091/18. When LIA is

injected after point of manufacture, precautions must be taken to ensure that the maximum dosages are not exceeded.

- (22) The use of an antioxidant additive is optional for jet fuels containing only petroleum-derived components. The antioxidant remains mandatory as part of the production process for synthetic components (see ASTM D7566). If added, the maximum limit is 24 mg/l in the final fuel. The list of approved antioxidant additives and their names are given in the following table (Annex A.2.4 of DEF STAN 91-091/18).

ANTI-OXIDANT (AO)	
Product	Qualification Reference
2,6-ditertiary-butyl-phenol	RDE/A/606
2,6 ditertiary-butyl-4-methyl-phenol	RDE/A/607
2,4-dimethyl-6-tertiary-butyl-phenol	RDE/A/608
75% minimum, 2,6-ditertiary-butyl-phenol 25% maximum, tertiary y tritertiary-butyl-phenols	RDE/A/609
55% minimum, 2,4-dimethyl-6-tertiary-butyl-phenol 15% minimum, 4 methyl-2,6-ditertiary-butyl-phenol Remainder, 30% maximum as a mixture monomethyl y dimethyltertiary-butyl-phenols	RDE/A/610
72% minimum, 2,4-dimethyl-6-tertiary-butyl-phenol 28% máximo, as a muxture tertiary-butyl-methyl-phenols y tertiary-butyl dimethyl phenols	RDE/A/611

- (23) The Metal Deactivator Additive (MDA) approved according to Annex A.3 of DEF STAN 91-091/18 is:

METAL DEACTIVATOR ADDITIVE (MDA)	
Product	Reference
N,N'-disalicylidene 1,2-propanediamine	RDE/A/650

DEF STAN 91-091/18 Annex A.3 details the restrictions on the use of MDA (to achieve compliance with the Thermal Oxidative Stability specification) at the point of manufacture and indicates the reporting requirements for producers when adding MDA at that point.

Note that routine use of MDA at the point of manufacture is not permitted (up to 5% of batches). The use of MDA at the point of manufacture is limited to 2.0 mg/L, except where copper contamination is present in the supply chain.

The use of MDA in the supply chain is also detailed, including the need to report thermal stability before and after MDA use, and the maximum concentration for MDA readdition.

- (24) Where necessary to meet the conductivity requirements an SDA, the following products may be used, according to DEF STAN 91-091/18 Annex A.4:

STATIC DISSIPATOR ADDITIVE (DSA)		
Product	Manufacturer	Qualification Reference
Stadis® 450	Innospec LLC	RDE/A/621
AvGuard SDA	Afton Chemical Ltd	RDE/A/DSFA/001

- (25) A lubricity improver, at the concentrations shown in the table below, may be added according to DEF STAN 91-091/18 Annex A.5. For further information, see Annex F of that standard. Other additives may be used in civil applications if they have been appropriately qualified by the certifying authorities and engine manufacturers.

ADITIVO MEJORADOR DE LUBRICIDAD (LIA)				
Product	Manufacturer	Qualification Reference	Minimum mg/l	Maximum mg/l
Innospec DCI-4A	Innospec LLC	RDE/A/662	9	23
Innospec DCI-6A	Innospec LLC	RDE/A/663	9	15
Nalco 5403	Nalco Chemical Co.	RDE/A/664	12	23
Unicor J	Dorf Ketal Chemicals	RDE/A/667	9	23
Nalco 5405	Nalco Chemical Co.	RDE/A/668	9	23
Spec Aid 8Q22	GE Betz	RDE/A/669	9	23

- (26) According to DEF STAN 91-091/18 Annex A.6, Fuel System Icing Inhibitor (FSII) may be used by agreement between purchaser and supplier.

Concentrations of 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. **Under no circumstances is this background level allowed in fuel that is to be delivered through a filter monitor.** This does not permit the continuous addition of FSII at these low concentrations.

FUEL SYSTEM ICING INHIBITOR (FSII)	
Product	Qualification Reference
Diethylene Glycol Monomethyl Ether	RDE/A/630

The material shall be added, where mandated, at a concentration of not less than 0.10% and not more than 0.15% by volume at the time of delivery to the purchaser. Suitable methods for determining the additive concentration are IP 424 and ASTM D 5006.

- (27) When LIA and FSII are to be used together it may be possible to add the LIA in a mixture with FSII. See DEF STAN 91-091/18 Annex A.7
Under no circumstances shall fuels containing FSII be delivered through a filter monitor

- (28) According to DEF STAN 91-091/18 Annex A.8, where necessary a leak detection additive may be added to the fuel to assist in detecting and locating leaks in ground based fuel storage, delivery and dispensing systems. It should be recognized that other leak detection techniques may have less environmental impact than Tracer A. The additive should only be used when other options have been considered, and its concentration should not exceed 1.0 mg/kg.

LEAK DETECTION ADDITIVE		
Product	Manufacturer	Qualification Reference
Tracer A (LDTA-A)	Praxair	RDE/A/640

(29) Test certificates shall state conformance to either of the two reference specifications. The Checklist is not a specification and manufacturing, and supply locations shall not release fuel only to the Checklist. If reference to the Checklist is to be made, the following statement should be used if the fuel meets the requirements of AFQRJOS Issue 35.

“It is certified that the samples have been tested using the Test Methods stated and that the Batch represented by the samples conforms with DEF STAN 91-091/18 and AFQRJOS Checklist Issue 35”.

Or

“It is certified that the samples have been tested using the Test Methods stated and that the Batch represented by the samples conforms with ASTM D1655 latest issue and AFQRJOS Checklist Issue 35”.

The minimum requirements of information to be included on the fuel’s point of manufacture batch certificate of quality shall be:

- Specification name, issue and any amendment number;
- Name, telephone number, email address and postal address of testing laboratory;
- Tank Number;
- Batch number or unique identifier;
- Quantity of fuel in the batch;
- Properties tested and including specification limit, test method and result of test;
- Additives, including qualification reference and quantity added;
- Name and position of authorised test certificate signatory or an electronic signature;
- Date of certification.