

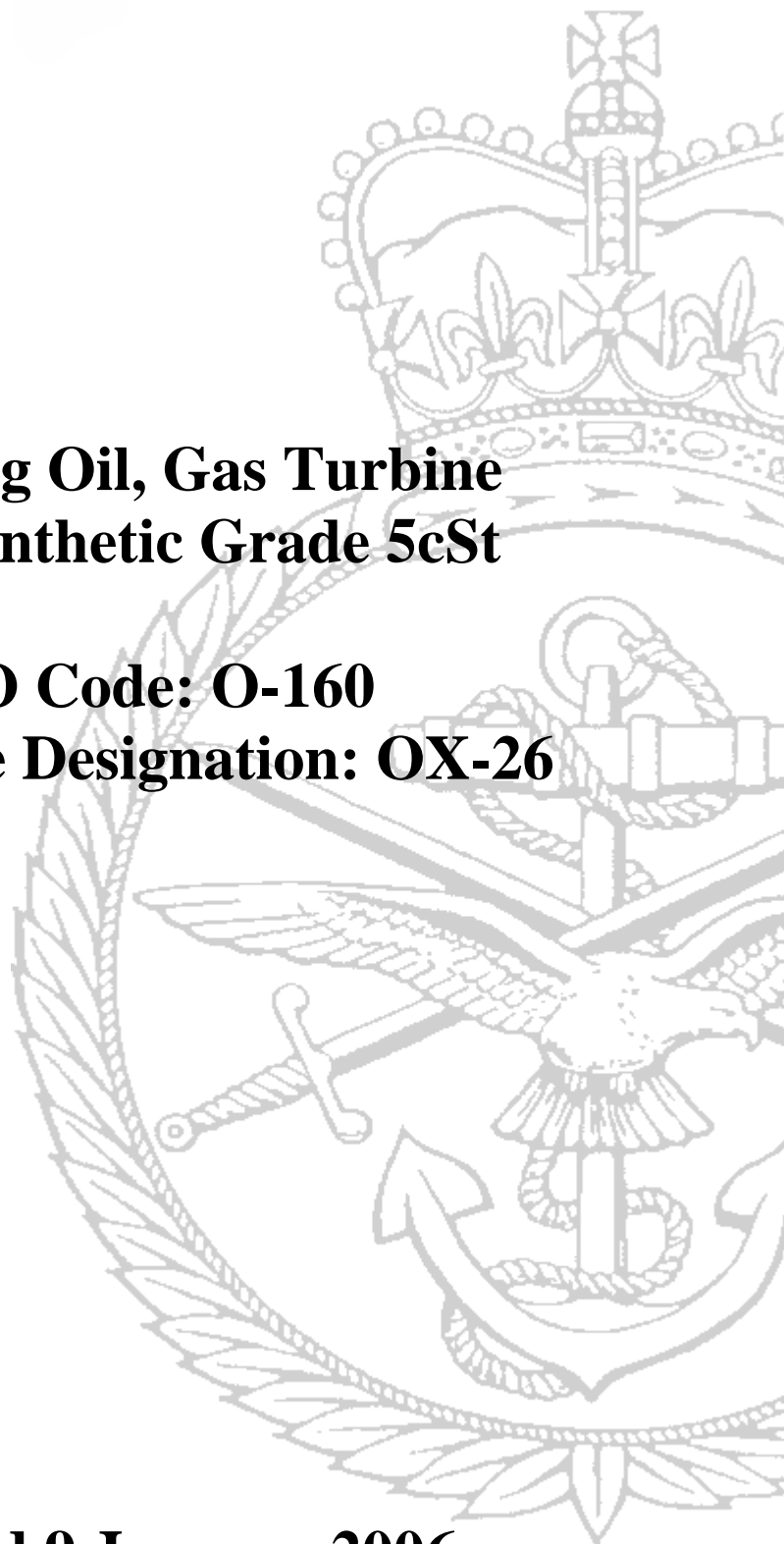


Ministry of Defence Defence Standard 91-100

Issue 3 Publication Date 31 August 2001

**Lubricating Oil, Gas Turbine
Engine, Synthetic Grade 5cSt**

**NATO Code: O-160
Joint Service Designation: OX-26**



**Reprinted 9 January 2006
to incorporate Amendment 1**

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Foreword

AMENDMENT RECORD

Amd No	Date	Text Affected	Signature and Date
1	9/01/06	Ref. to Antioxidant limits Para 4.2 & 4.3, Standard formatted to the Template V2.	SPM3

REVISION NOTE

This standard is raised to Issue 3 to update its content.

HISTORICAL RECORD

This standard supersedes the following:

Def Stan 91-100 Issue 2 dated 31 December 1997

Def Stan 91-100 Issue 1 dated 7 October 1994

DERD 2497 Issue 3 dated November 1976

- a) This standard provides requirements for Gas Turbine Engine Lubricating Oil.
- b) This standard has been produced on behalf of the Defence Fuels and Lubricants Committee (DF&LC) by the Aviation Propulsion Fuels and Lubricants Advisory Group (APFLAG).
- c) This standard has been agreed by the authorities concerned with its use and is intended to be used whenever relevant in all future designs, contracts, orders etc. and whenever practicable by amendment to those already in existence. If any difficulty arises which prevents application of the Defence Standard, UK Defence Standardization (DStan) shall be informed so that a remedy may be sought.
- d) Any enquiries regarding this standard in relation to an invitation to tender or a contract in which it is incorporated are to be addressed to the responsible technical or supervising authority named in the invitation to tender or contract.
- e) Compliance with this Defence Standard shall not in itself relieve any person from any legal obligations imposed upon them.
- f) This standard has been devised solely for the use of the Ministry of Defence (MOD) and its contractors in the execution of contracts for the MOD. To the extent permitted by law, the MOD hereby excludes all liability whatsoever and howsoever arising (including, but without limitation, liability resulting from negligence) for any loss or damage however caused when the standard is used for any other purpose.

Introduction

Standards for Defence - Lubricating Oil, Gas Turbine Engine, Synthetic Grade 5 cSt - NATO Code: O-160, JSD: OX-26

1 Scope

1.1 This Defence Standard specifies the requirements for one grade of synthetic lubricating oil intended primarily for use in aircraft gas turbine engines and relevant ancillary equipment.

1.2 Lubricating oil provided to this specification shall possess satisfactory performance and properties when used in appropriate vehicles and/or gas turbines and ancillary equipment operated by the Crown.

2 Warning

The Ministry of Defence (MOD), like its contractors, is subject to both United Kingdom and European laws regarding Health and Safety at Work. All Defence Standards either directly or indirectly invoke the use of processes and procedures that could be injurious to health if adequate precautions are not taken. Defence Standards or their use in no way absolves users from complying with statutory and legal requirements relating to Health and Safety at Work.

3 Normative References

3.1 The publications shown below are referred to in the text of this standard. Publications are grouped and listed in alpha-numeric order.

IP 15 (ASTM D97, ISO 3016, BS2000:Part 15)	Determination of Pour Point
IP 36 (ASTM D92)	Determination of Open Flash and Fire Point – Cleveland Method
IP 71 (ASTM D445, ISO 3104 BS2000:Part 71)	Determination of Kinematic Viscosity and Calculation of Dynamic Viscosity
IP 146 (ASTM D892, BS2000: Part 146)	Determination of Foaming Characteristics of Lubricating Oils
IP 166	Determination of Load-Carrying Capacity of Lubricants – IAE Gear Machine Method.
IP 365 (ISO 12185, BS2000: Part 365)	Determination of Density – Oscillating U-Tube Method.
IP 367	Method for Determination and Application of Precision Data in (BS2000:Part 367 Relation to Methods of Test for Petroleum products.
BS EN ISO 4259)	
Def Stan 05-50 (Part 61)	Methods for Testing Fuels, Lubricants, and Associated Products.
Method 1:	Methods for Testing Gas Turbine Engine Synthetic Lubricants.
Method 3	Confined Heating Stability.
Method 6:	Corrosivity
Method 8	Hydrolytic Stability.
Method 9	Miscibility and Compatibility.
Method 14	Resistance to Oxidation and Thermal Decomposition
Method 22	Catalytic Oxidation Test
	Assessment of the Compatibility of Gas Turbine Lubricants with Elastomers

DEF STAN 91-100 Issue 3

Def Stan 05-52 (Part 1)	Markings for the Identification of Fuels, Lubricants and Associated Products: Containers Holding 210 Litres or Less.
Def Stan 91-98	Lubricating Oil, Gas Turbine Engine, Synthetic Grade 7.5 cSt NATO Code O-149. Joint Service Designation OX-38.
Def Stan 91-101	Lubricating Oil, Gas Turbine Engine, Synthetic Grade 5 cSt. NATO Code O-156. Joint Service Designation: OX-27 and OX-28.
ASTM D2532	Standard Test Method for Viscosity and Viscosity Change after Standing at Low Temperature of Aircraft Turbine Lubricants
FED-STD-791 No 3010	Solid Particle Contamination in Aircraft Turbine Engine Lubricants (Gravimetric Procedure)
SAE AIR 4978	Temporary Methods for Assessing the Load Carrying Capacity of Aircraft Propulsion Systems.
SAE ARP 5088	Test Method for the Determination of Total Acidity in Polyol Ester and Diester Gas Turbine Lubricants by Automatic Potentiometric Titration
SAE ARP 5996	Evaluation of Coking Propensity of Aviation Lubricants by the Hot Liquid Process Simulator (HLPS) Single Phase Flow Technique.

3.2 Reference in this Standard to any normative references means in any Invitation to Tender or contract the edition and all amendments current at the date of such tender or contract unless a specific edition is indicated.

3.3 In consideration of clause **3.2** above, users shall be fully aware of the issue and amendment status of all normative references, particularly when forming part of an Invitation to Tender or contract. Responsibility for the correct application of standards rests with users.

3.4 DStan can advise regarding where normative references documents are obtained from. Requests for such information can be made to the DStan Helpdesk. How to contact the helpdesk is shown on the outside rear cover of Def Stans.

4 Materials

4.1 The lubricating oil shall consist of a stable homogeneous blend of synthetic base oil and suitable additives.

4.2 The use of the additives 2,6-di-tert-butylphenol and 2,6-di-tert-butyl-4-methylphenol is not permitted and the incidental presence of these materials is limited in total to 50mg/l of the finished lubricant.

4.3 The Ministry of Defence reserves the right to require that the oil and any components used are subjected to toxicological and physiological tests to ascertain their suitability for use.

“NOTE: Products supplied to this standard may be used on HM Submarines and shall be subject to a Material Toxicity Hazard Review. Details for obtaining the Material Toxicity Hazard Review are available from the Technical Authority.”

5 Product Conformity Certification

5.1 Product Conformity Certification (PCC) procedure applies to product supplied for MoD use against this standard.

5.2 Before any product can be considered as complying with this standard, the manufacturer must demonstrate to the Technical Authority that the product meets all the requirements of this standard including Annex A. At this time a declaration, in confidence, of the formulation including source and identification of all components, and place of manufacture is required. The Technical Authority will then assign a unique identification reference to this product, which becomes a Technically Acceptable Product. The Sponsor will maintain a list of Technically Acceptable Products in a Technically Acceptable Products List (TAPL).

5.3 Once accepted as a Technically Acceptable Product, no change to the product so referenced shall be made without prior notification to the Technical Authority. Only those products that are listed on the TAPL may be stated as complying with the requirements of this specification.

5.4 Before any changes are made to the product, the supplier shall notify the Technical Authority of the proposed changes. The supplier shall also certify that the performance of the product as defined by **Table 1** has not been impaired by the changes. Evidence supporting this certification shall be provided to the Technical Authority and shall include the necessary OEM approvals (see Annex A). Once such certification and evidence has been received, the changed product will be assigned a new discrete identification reference number, and will be added to the TAPL.

5.5 When supplying products to the MoD, the supplier shall certify that:

5.5.1 The product delivered complies with the formulation declared under clause 5.2 or 5.4 of this specification.

5.5.2 Representative samples of the finished product comply with the requirements of tests 1 to 9 of **Table 1**. The Technical Authority reserves the right to require additional evidence that the product is compliant.

5.6 If any sample taken from the consignment is found not to comply with any of the requirements of this standard, the whole consignment may be rejected.

6 Testing

6.1 Properties of the product shall not exceed the maximum nor be less than the minimum values set out in Table 1.

6.2 Methods quoted in the table are referee methods and shall be used in cases of dispute. Alternative technically equivalent methods may be used with the agreement of the responsible Technical Authority. Alternative methods that are jointed with the referee methods are identified in Annex B. Jointed methods may be used in lieu of the referee methods without restriction provided that their jointed status is in existence at the time of use.

6.3 IP 367, which covers the use of precision data, shall be used for the interpretation of test results.

Table 1 Test Requirements

Test	Property	Units	Limits	Method
1	Appearance		Clear, bright and free from undissolved water, sediments and other impurities.	Visual examination
2	Density at 15°C	kg m ⁻³	Report	IP 365
3	Flash Point	°C	Min 210	IP 36
4	Pour Point	°C	Max Minus 54	IP 15
5	Total Acid Number			SAE ARP 5088
5.1	Base Stock	mg KOH g ⁻¹	Max 0.1	
5.2	Fully Formulated Oil	mg KOH g ⁻¹	Report	
6	Viscosity, Kinematic			IP 71
6.1	at 100°C	mm ² s ⁻¹	Min 4.90 Max 5.40	
6.2	at 40°C	mm ² s ⁻¹	Max 30.00	
6.3	at Minus 40°C	mm ² s ⁻¹	Max 13000	
7	Foaming Characteristics Sequence I, II and III			IP 146
7.1	Tendency	ml	Max 25	Report the Stability after 1 minute
7.2	Stability	ml	Nil	

Table 1 Test Requirements

Test	Property	Units	Limits	Method
8	Solid Particle contamination			FED-STD-791 Method 3010
8.1	Sediment	mg l ⁻¹	Max 10	
8.2	Total Ash of Sediment (See NOTE 1)	mg l ⁻¹	Max 1	
9	Trace Element Content			Atomic Emission Spectrometry (See NOTE 2)
	Aluminium	mg kg ⁻¹	Max 2	
	Iron	mg kg ⁻¹	Max 2	
	Chromium	mg kg ⁻¹	Max 2	
	Silver	mg kg ⁻¹	Max 1	
	Copper	mg kg ⁻¹	Max 1	
	Tin	mg kg ⁻¹	Max 4 (See NOTE 3)	
	Magnesium	mg kg ⁻¹	Max 2	
	Nickel	mg kg ⁻¹	Max 2	
	Titanium	mg kg ⁻¹	Max 2	
	Silicon	mg kg ⁻¹	Max 10	
	Lead	mg kg ⁻¹	Max 2	
	Molybdenum	mg kg ⁻¹	Max 3	
	Zinc	mg kg ⁻¹	Max 2	
10	Confined Heat Stability:			Def Stan 05-50 (Part 61) Method 1
10.1	S Temperature after 192 Hours (S ₃ ¹⁹²)	°C	Report	
10.2	Viscosity Stability at 100°C: viscosity decrease	%	Max 5.0	

Table 1 Test Requirements

Test	Property	Units	Limits	Method
11	Corrosivity Weight Change			Def Stan 05-50 (Part 61) Method 3
11.1	Procedure 3			
	Aluminium alloy	mg cm ⁻²	Minus 0.1 to Plus 0.1	
	Copper	mg cm ⁻²	Minus 1.0 to Plus 0.1	
	Titanium Copper Alloy	mg cm ⁻²	Minus 0.2 to Plus 0.1	
	Copper-Nickel-Silicon Alloy	mg cm ⁻²	Minus 0.5 to Plus 0.1	
	Mild Steel	mg cm ⁻²	Report	
	Leaded Bronze	mg cm ⁻²	Minus 0.5 to Plus 0.1	
	High Carbon Chromium Steel	mg cm ⁻²	Minus 0.2 to Plus 0.1	
	Leaded Brass	mg cm ⁻²	Minus 1.5 to Plus 0.1	
	Nickel Chromium Case Hardened Steel	mg cm ⁻²	Minus 0.2 to Plus 0.1	
	High Speed Steel	mg cm ⁻²	Minus 0.2 to Plus 0.1	
	Appearance of the metal Specimens after test		Shall show no evidence of etching or pitting	Visual examination under 10 X Magnification
	Mild Steel			
	High Carbon Chromium Steel			
	Nickel Chromium Case Hardened Steel			
	High Speed Steel			
11.2	Procedure 4			
	Nickel	mg cm ⁻²	Minus 0.1 to Plus 0.1	
	Silver	mg cm ⁻²	Minus 0.2 to Plus 0.1	
11.3	Procedure 5			
	Magnesium alloy	mg cm ⁻²	Report	

Table 1 Test Requirements

Test	Property	Units	Limits	Method
11.4	Procedure 6 Chromated Magnesium Alloy. Chromated Magnesium Alloy, Phenolic Resin Coated	mg cm ⁻² mg cm ⁻²	Report Report	
12	Coking Propensity Maximum tube temperature of 375°C and test duration of 20 hours.		Report	SAE ARP 5996
13	Elastomer Compatibility			Def Stan 05-50 (Part 61) Method 22
13.1	Weight change (after 24 hours) Nitrile Fluorocarbon LCS Fluorocarbon Silicone	% mass % mass % mass % mass	Report Report Report Report	
13.2	Weight change (after 120 hours) Nitrile Fluorocarbon LCS Fluorocarbon Silicone	% mass % mass % mass % mass	Report Report Report Report	
13.3	Embrittlement Procedure		Report	
14	Miscibility and Compatibility (See NOTES 4 and 5)			Def Stan 05-50 (Part 61) Method 8
14.1	Miscibility at 210°C		There shall be no visible signs of separation, gelation or formation of insoluble matter	Procedure A
14.2	Miscibility at Minus 40°C		There shall be no visible signs of separation, gelation or formation of insoluble matter.	Procedure B

Table 1 Test Requirements

Test	Property	Units	Limits	Method
14.3	Compatibility, Increase in Toluene Insolubles (See NOTE 5)	% mass	Max 0.05	Procedure C
15	Hydrolitic Stability $D_{1.5}^{90}$	Hours	Min 24	Def Stan 05-50 (Part 61) Method 6
16	Load Carrying Ability		Report	See NOTE 6
17	High Temperature Oxidative Stability			Def Stan 05-50 (Part 61) Method 9
17.1	Temperature Parameters after 192 hours			
	E Temperature	°C	Min 185	
	A Temperature	°C	Min 185	
	V Temperature	°C	Min 185	
	B Temperature	°C	Min 210	
	Z Temperature	°C	Report	
	Z^{192} -B ¹⁹²	°C	Max 10	
17.2	Effective Life			
17.2.1	at 200°C			
	Volatilisation Loss E	hours	Min 100	
	Acidity Increase A	hours	Min 60	
	Viscosity Increase V	hours	Min 60	
	Insolubles Increase B	hours	Min 250	
17.2.2	at 250°C			
	Volatilisation Loss E	hours	Min 3.5	
	Acidity Increase A	hours	Min 1.0	
	Viscosity Increase V	hours	Min 2.0	
	Insolubles Increase B	hours	Min 18	
18	Catalytic Oxidation: Solidus(Z^{192}) Temperature Change	°C	Max 15	Def Stan 05-50(Part 61) Method 14
19	Viscosity Kinematic High Temperature 200°C	mm^2s^{-1}	Min 1.25	IP 71 (See NOTE 7)

Table 1 Test Requirements

Test	Property	Units	Limits	Method
20	Viscosity Stability, Low Temperature at Minus 40°C. Viscosity Change from Original	%	Max 6	ASTM D2532
21	OEM Certification	N/A	OEM certification is required for unrestricted use in all relevant systems	See Annex A

NOTE 1 If the total sediment does not exceed 1 mg/1, the ash content requirement shall be waived.

NOTE 2 The trace metal content of the lubricant shall be determined with an atomic emission spectrometer. Appropriate spectrometric calibration standards, covering the concentration ranges of interest, shall be used.

NOTE 3 When testing is performed by a facility in the US Department of Defence Joint Oil Analysis Program, Pensacola, FL, USA, the limit for Tin is 11 mg/kg. For other spectrometers and test methods, the limit for tin is 4 mg/kg.

NOTE 4 Miscibility and compatibility is to be shown for all oils complying with the requirements of this standard, Def Stan 91-101 and 91-98

NOTE 5 The test temperature shall be 210°C for demonstrating compatibility with oils to this standard; 205 °C for Def Stan 91-101 and 170°C for Def Stan 91-98.

NOTE 6 This Test Method is under review. Until further notice the test to be applied will be IP 166 Condition A and C with the procedures modified as follows:

1. Test oil temperature of 110°C for both conditions.
2. All four tests shall first be run on Reference oil RDE/O/623 and the reverse faces of the four gears used to determine the failure modes. Neither oil shall be changed for the other during the sequence of four tests with different gears.
3. All eight gears used (Condition A and C) shall be from the same batch of gears.
4. The test report shall identify each pair of results comprising the means of the initial and complete failure loads obtained for the reference oil and test oil on opposite faces of the same gear.
5. Calculate individual relative failure loads by expressing, for each paired result, the test oil results as a percentage of the reference oil results.

Alternatively, with the agreement of the technical authority, the Aviation Lubricant Tribology Evaluator (ALTE), SAE AIR 4978, may be used.

NOTE 7 As an alternative to determining the viscosity at 200°C by IP 71, the value may be estimated by extrapolation from viscosity determinations at 40°C and 100°C.

7 Keeping Qualities

The product, when suitably stored in its original sealed containers shall retain the properties described in this Standard for a period of not less than 12 months in temperate climates and not less than six months in tropical climates, from the date defined in the contract.

8 Containers and Marking of Containers

8.1 The product shall be supplied in sound, clean and dry containers, suitable for the product and in accordance with the requirements of the contract or order.

8.2 Coatings and paint finishes shall comply with the requirements for the contract or order. Markings shall be in accordance with the requirements of Def Stan 05-52 (Part 1). The product identification shall be as specified in the contract or order.

8.3 It shall be the responsibility of the contractor to comply with any legal requirements for the marking of containers.

Annex A

Original Equipment Manufacturer (OEM) Approval of The Product

A.1 Products Assigned JSD OX-26

A.1.1 The products defined by this specification shall be approved by the appropriate OEMs for use in certain aircraft systems operated by the MoD. Details of the OEMs and the systems for which approval must be sought may be obtained from the address below.

AFTM
Defence Fuels Group
Defence Petroleum Centre
West Moors
Wimborne
Dorset
BH21 6QS

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GLASGOW G2 8EX

DStan Helpdesk

Tel 0141 224 2531/2

Fax 0141 224 2503

Internet e-mail enquiries@dstan.mod.uk

File Reference

The DStan file reference relating to work on this standard is D/DStan/91/100

Contract Requirements

When Defence Standards are incorporated into contracts users are responsible for their correct application and for complying with contractual and statutory requirements. Compliance with a Defence Standard does not in itself confer immunity from legal obligations.

Revision of Defence Standards

Defence Standards are revised as necessary by an up issue or amendment. It is important that users of Defence Standards should ascertain that they are in possession of the latest issue or amendment. Information on all Defence Standards can be found on the DStan Website www.dstan.mod.uk, updated weekly and supplemented regularly by Standards in Defence News (SID News). Any person who, when making use of a Defence Standard encounters an inaccuracy or ambiguity is requested to notify UK Defence Standardization (DStan) without delay in order that the matter may be investigated and appropriate action taken.