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Lubricants, industrial oils and related products (Class L) — Family X (Greases) — Specifications

Lubrifiants, huiles industrielles et produits connexes (classe L) — Famille X (Graisses) — Spécifications

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*, Subcommittee SC 4, *Classifications and specifications*.

This second edition cancels and replaces the first edition (ISO 12924:2010), which has been technically revised. It also incorporates the Technical Corrigendum ISO 12924:2010/Cor 1:2012.

The main changes are as follows:

— introduction of environmentally acceptable greases (suffix EA added to the symbol);

— additional data table added to provide to the end user complementary information about important properties of the grease.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

According to Reference [25], grease is a lubricant which has been thickened in order that it remain in contact with the moving surfaces and not leak out under gravity or centrifugal action, or be squeezed out under pressure. Additives may be included to bring special properties like anti-oxidants, rust and corrosion inhibitors, anti-wear and extreme pressure additives, solid lubricants.

Greases are used to keep the lubricant in place in the lubricated organs or mechanisms. The advantages of greases are the reduction of the construction and maintenance costs, the simplicity of the sealing systems, and the possibility for life lubrication.

One of the drawbacks of greases versus liquid lubricants is that they do not easily remove heat and cannot be filtered. So greases limit the operating speed of some mechanisms.

Due to the variety of base oils and thickeners, there is a wide variety of greases. The selection of the liquid lubricant and the thickener depends on the properties required. The low temperature properties are governed by the liquid lubricant characteristics, mainly its flow properties at low temperature. The high temperature properties are linked to the type of thickener and to the heat stability of the liquid lubricant.

Greases can be formulated to meet environmental acceptability requirements (toxicity and biodegradability).

The purpose of this document is to provide guidance to suppliers and end users of greases and to manufacturers of grease-lubricated equipment.

Lubricants, industrial oils and related products (Class L) — Family X (Greases) — Specifications

1 Scope

This document establishes the specifications relative to family X (greases) for lubricants, industrial oils and related products of Class L (see ISO 6743-9). Those greases are mainly used for the lubrication of anti-friction bearings fitted on machines, vehicles, etc.

This document is written in a general form so that its application can accommodate various climatic conditions throughout the world. It also stipulates the requirements for the lubricating grease at the time of the delivery.

NOTE 1 This document is intended to be read in conjunction with ISO 6743-9.

NOTE 2 Greases for gear applications are specified in ISO 12925-3.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2137, *Petroleum products and lubricants — Determination of cone penetration of lubricating greases and petrolatum*

ISO 4259-2, *Petroleum and related products — Precision of measurement methods and results — Part 2: Interpretation and application of precision data in relation to methods of test*

ISO 6341, *Water quality — Determination of the inhibition of the mobility of Daphnia magna Straus (Cladocera, Crustacea) — Acute toxicity test*

ISO 6743-9, *Lubricants, industrial oils and related products (class L) — Classification — Part 9: Family X (Greases)*

ISO 7120, *Petroleum products and lubricants — Petroleum oils and other fluids — Determination of rust-preventing characteristics in the presence of water*

ISO 7346-1, *Water quality — Determination of the acute lethal toxicity of substances to a freshwater fish [Brachydanio rerio Hamilton-Buchanan (Teleostei, Cyprinidae)] — Part 1: Static method*

ISO 8692, *Water quality — Fresh water algal growth inhibition test with unicellular green algae*

ISO 9439, *Water quality — Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium — Carbon dioxide evolution test*

ISO 10253, *Water quality — Marine algal growth inhibition test with Skeletonema sp. and Phaeodactylum tricornutum*

ISO 11007-1, *Petroleum products and lubricants — Determination of rust-prevention characteristics of lubricating greases — Part 1: Dynamic wet conditions*

ISO 11009, *Petroleum products and lubricants — Determination of water washout characteristics of lubricating greases*

ISO 13737, *Petroleum products and lubricants — Determination of low-temperature cone penetration of lubricating greases*

ISO 14593, *Water quality — Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium — Method by analysis of inorganic carbon in sealed vessels (CO2 headspace test)*

ISO 14669, *Water quality — Determination of acute lethal toxicity to marine copepods (Copepoda, Crustacea)*

ISO 23572, *Petroleum products — Lubricating greases — Sampling of greases*

EN 16807, *Liquid petroleum products - Bio-lubricants - Criteria and requirements of bio-lubricants and bio-based lubricants*

EN 17181, *Lubricants - Determination of aerobic biological degradation of fully formulated lubricants in an aqueous solution - Test method based on CO2-production*

ASTM D6866, *Standard Test Method for Determining the Biobased Content of Solid, Liquid and Gaseous Samples using Radiocarbon Analysis*

ASTM D1478, *Standard Test Method for Low-Temperature Torque of Ball Bearing Grease*

DIN 51805-2, *Testing of lubricants - Determination of flow pressure of lubricating greases according to Kesternich method – Part 2: Automatic method*

DIN 51813, *Testing of lubricants - Determination of the content of foreign solid matters in lubricating greases - Particle sizes above 25 µm*

DIN 51819-2, *Testing of lubricants - Mechanical-dynamic testing in the roller bearing test apparatus FE8 - Part 2: Test method for lubricating greases - applied test bearing: oblique ball bearing or tapered roller bearing*

DIN 51821-1, *Testing of lubricants - Test using the FAG roller bearing grease testing apparatus FE9 – Part 1: General working principles*

DIN 51821-2, *Testing of lubricants - Test using the FAG roller bearing grease testing apparatus FE9 – Part 2: Test method*

NF T60-629, *Petroleum products and lubricants - Low temperature torque of ball bearing greases*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
upper operating temperature
highest operating temperature at which a grease is able to continuously lubricate a bearing during sufficient time without failure

3.2
lower operating temperature
lowest operating temperature at which a grease can operate in a mechanism without failure

Note 1 to entry: The lowest operating temperature can be expressed in the following ways:

— temperature at which the pressure in dispensing pipes remains acceptable to allow flow of grease;

— temperature at which the resisting torque due to grease hardening remains acceptable to allow a bearing to rotate;

— temperature at which a grease keeps enough plasticity to avoid mechanical blocking of mechanisms.

4 Sampling

Sampling of bearing greases for the purpose of this document, unless otherwise specified, shall be carried out in accordance with the pertinent procedure described in ISO 23572. The sample shall be evaluated on a representative portion. Any drum, barrel, tanker compartment or any type of container delivered to the end user may be sampled and analysed at the discretion of the purchaser.

5 Requirements for greases

5.1 General requirements

The designation of greases shall be in accordance with ISO 6743-9, using the following manner:

ISO - L - X - symbol 1 - symbol 2 - symbol 3 - symbol 4 - NLGI consistency number

where

— symbol 1 is a measurement of the lower operating temperature, symbols A to E;

— symbol 2 is a measurement of the upper operating temperature, symbols A to G;

— symbol 3 is a measurement of the water contamination and anti-rust protection, symbols A to I;

— symbol 4 is a measurement of the ability to lubricate under high loads, symbol A or B;

— NLGI (National Lubricating Grease Institute) consistency number is defined in ISO 6743-9 through an evaluation of the penetration in accordance with ISO 2137.

The designation can be completed in the following manner, adding the suffix:

— "EA" for environmentally acceptable greases.

The requirements and test methods specified in Table 1 to Table 7 shall be followed in order to determine the value of each symbol used in the classification system.

Most of the test methods specified contain a precision statement. In cases of dispute, if the conditions of ISO 4259 (all parts) can be met with the relevant test method, the procedure described in ISO 4259-2 shall apply.

NOTE 1 Greases having the same classification according to ISO 6743-9 and the same specification according to this document are not necessarily compatible with each other. Blending of non-compatible greases can lead to equipment failure. Before changing from one grease to another in an equipment, it is preferable to consult the grease suppliers.

NOTE 2 In the classification according to ISO 6743-9, a grease cannot have more than one symbol. This symbol is expected to correspond to the most severe conditions of temperature, water contamination and load in which the grease can be used.

5.2 Symbol 1 — Lower operating temperature

The lower operating temperature shall be determined by the following three criteria (see Table 1):

— the starting and the running torque, in accordance with ASTM D1478 or NF T60-629;

— the flow pressure, in accordance with DIN 51805-2;

— the low temperature penetrability, in accordance with ISO 13737.

Following the criterion selected, the "symbol 1" is completed by a suffix letter between brackets:

— (L) when using the starting/running torque;

— (F) when using the flow pressure;

— (P) when using the low temperature penetrability.

Table 1 — Lower operating temperature — Symbol 1

Lower operating temperature °C	Low temperature torque			Flow pressure hPa		Penetrability 1/10 mm	
		Starting torque mN·m	Running torque mN·m				
	Symbol 1	Value	Value	Symbol 1	Value	Symbol 1	Value
0	A(L)	≤1 000	≤100	A(F)	≤1 400	A(P)	≥140
−20	B(L)			B(F)		B(P)	≥120
−30	C(L)			C(F)		C(P)	≥120
−40	D(L)			D(F)		D(P)	≥100
< −40	E(L)			E(F)		E(P)	≥100
Test method	ASTM D 1478 or NF T60-629			DIN 51805-2		ISO 13737	

5.3 Symbol 2 — Upper operating temperature

The upper operating temperature shall be determined using DIN 51821-1 and DIN 51821-2 (see Table 2).

For greases with an upper operating temperature above 120 °C, the F_{50} bearing life shall be above 100 h at the considered upper operating temperature.

For greases with base oil kinematic viscosities above 300 mm^2/s at 40 °C, the rotating speed of 6 000 min^{-1} (628,32 rad/s) is considered too high. The FAG FE 9 machine, as described in DIN 51821-1, allows for an alternative rotating speed of 3 000 min^{-1} (314,16 rad/s). If the latter speed is used to assess the upper operating temperature of a grease, the "symbol 2" shall be supplemented by the suffix letter S between brackets: (S).

Table 2 — Upper operating temperature — Symbol 2

Upper operating temperature °C	Symbol 2	Bearing life h
90	B	No requirement
120	C	F_{50} > 100 h at the upper operating temperature
140	D	
160	E	
180	F	
>180	G	
Test methods	-	DIN 51821-1 and DIN 51821-2; test with the FAG FE9 grease testing apparatus, procedure B/1500/6000 or B/1500/3000 for greases with base oil kinematic viscosities above 300 mm^2/s at 40 °C [a].

[a] Test results from the comparable tests with the A configuration may also be accepted.

NOTE Provided that the first three bearings tested run more than 350 h, ASTM D3336 performed on 5 bearings with a F_{50} > 500 h at the upper operating temperature can be used as an alternative to the test shown in DIN 51821- 2 to define the upper operating temperature.

5.4 Symbol 3 — Water contamination and rust protection

Symbol 3 is a combination of the level of water resistance, as evaluated by means of the water washout test which shall be in accordance with ISO 11009, and protection against rust, as evaluated by rust-prevention test which shall be in accordance with ISO 11007-1 (see Table 3).

The water washout losses shall be determined at 38 °C for greases with a "symbol 2" from B to D and at 79 °C for the greases with a "symbol 2" from E to G.

Table 3 — Water resistance and rust protection — Symbol 3

Symbol 3	Water washout losses requirement %	Rust-prevention requirement rating
A	No requirement	No requirement
B	No requirement	1-1 max, distilled water
C	No requirement	2-2 max, salt water in accordance with ISO 7120
D	<30	No requirement
E	<30	1-1 max, distilled water
F	<30	2-2 max, salt water in accordance with ISO 7120
G	<10	No requirement
H	<10	1-1 max, distilled water
I	<10	2-2 max, salt water in accordance with ISO 7120
Test method	ISO 11009	ISO 11007-1

5.5 Symbol 4 — Ability to lubricate under high loads

The tests to evaluate the ability to lubricate under high load conditions can be either the 4-ball test, considering only the weld load, or the high frequency linear oscillation test machine (SRV). Follow Table 4 for the requirements using either of these two tests.

Two levels of extreme-pressure performance are defined: B for the conventional level and B(H) for the high level.

Table 4 — Ability of a grease to lubricate under high load conditions — Symbol 4

Symbol 4	Requirement	Test method
A	None	
B	≥250 kg	ISO 20623 (European conditions) or ASTM D2596 (US conditions)
	OK load ≥600 N	ISO 19291 test mode 4 at 80 °C
B(H)	≥400 kg	ISO 20623 (European conditions) or ASTM D2596 (US conditions)
	OK load ≥800 N	ISO 19291 test mode 4 at 80 °C

5.6 NLGI consistency number

The NLGI consistency number shall be evaluated by penetration using 60 strokes at 25 °C in accordance with ISO 2137. Table 5 shows the correspondence between the NLGI consistency number and the penetration.

NOTE A gap exists in the penetration numbers between the different NLGI grades. This allows for "unofficial" half grades, e.g. a grease with a penetration of 300 1/10 mm, intermediate between the maximum allowed penetration for the NLGI 2 grade and the minimum allowed penetration for the NLGI 1 grade, to be designated as a "1,5 grade".

Table 5 — NLGI consistency number

NLGI grade	Penetration (using 60 strokes at 25 °C) 1/10 mm	Test method
000	445 to 475	ISO 2137
00	400 to 430	
0	355 to 385	
1	310 to 340	
2	265 to 295	
3	220 to 250	
4	175 to 205	
5	130 to 160	
6	85 to 115	

5.7 Environmentally acceptable greases — EA

5.7.1 General

The requirements published in EN 16807 are intended as horizontal requirements for all bio-based lubricants, and represent minimum requirements compared to, for example, the European Ecolabel for Lubricants[24]. With the exception of content of carbon of biological origin, these requirements are also seen as minimum requirements for any other type of environmental standard existing in the world.

Greases with the suffix "EA" shall comply with the requirements of EN 16807, if applicable and in accordance with Table 6.

Table 6 — Environment requirements for greases with suffix "EA"

Characteristic of test	Unit	Requirement	Test method
Biodegradability, min.[ac]	%	50	ISO 14593[d] or ISO 9439[d] or EN 17181[d]
Toxicity EC 50 (algal growth inhibition or marine algal growth inhibition)	mg/l	>100	ISO 8692 or ISO 10253

[a] All actual eco-labels, regulations and recommendations are referring to the ISO and EN test methods given in this table. Claims of biodegradability in other environments (e.g. landfill) currently lack appropriate standards, although development work is ongoing.

[b] Applies only to ester-based greases and other bio-based greases.

[c] All types of greases may not completely fulfil this requirement.

[d] The interpretation of the results of this test method is currently limited due to missing or inapplicable precision data. In case of dispute or doubt, a referee test should be performed in an independent laboratory.

Table 6 *(continued)*

Characteristic of test	Unit	Requirement	Test method
EC50 (daphnia or copepods)	mg/l	>100	ISO 6341[d] or ISO 14669[d]
LC 50 (fish)	mg/l	>100	ISO 7346-1[d]
Content of carbon of biological origin, min[b]	%	25	ASTM D6866

[a] All actual eco-labels, regulations and recommendations are referring to the ISO and EN test methods given in this table. Claims of biodegradability in other environments (e.g. landfill) currently lack appropriate standards, although development work is ongoing.

[b] Applies only to ester-based greases and other bio-based greases.

[c] All types of greases may not completely fulfil this requirement.

[d] The interpretation of the results of this test method is currently limited due to missing or inapplicable precision data. In case of dispute or doubt, a referee test should be performed in an independent laboratory.

5.7.2 Biodegradability

In case of dispute, the referee method for compliance with the biodegradability requirement shall be in accordance with EN 17181. In order to check the procedure during the referee process, a reference compound of known biodegradability shall be tested in parallel. Aniline may be used when testing water-soluble test compounds; for poorly soluble test substances high oleic reference oil (HORO) should be used.

5.7.3 Acute daphnia or copepods toxicity

In case of dispute, the referee method for compliance with the invertebrate requirement, shall be ISO 6341. In order to check the procedure during the referee process, a reference compound of known toxicity shall be tested in parallel. Tetrapropylenebenzenesulfonic acid may be used when testing water-soluble test compounds; for poorly soluble test substances potassium 2,4,5 trichlorophenoxyacetate should be used.

The biodegradability and aquatic toxicity tests should be performed in a laboratory operating in accordance with ISO/IEC 17025 or according to good laboratory practice (GLP).

6 Additional data

Additional data may be presented upon customer's request. Annex A suggests data that can be discussed upon (see Table A.1).

7 Example of grease designation

The grease shall be explained with the designation ISO – L – XB(L)DHA3:

— B(L) indicates that the grease can be used at a temperature down to –20 °C and that this is the low temperature of the starting/running torque that has been chosen to determine the lower temperature limit of use;

— D indicates that the grease can be used at a temperature up to 140 °C;

— H indicates that the grease protects against corrosion in distilled water and withstands to washout conditions;

— A indicates that the grease does not own particular extreme-pressure characteristics;

— 3 indicates that the grease is of NLGI 3 grade.

Hence, this grease has the following properties:

— a starting torque which is ≤1 000 mN·m and a running torque ≤100 mN·m at –20 °C according to ASTM D1478;

— an endurance life of F_{50} ≥ 100 h at 140 °C according to DIN 51821-2;

— water washout losses of <10 % according to the test in ISO 11009 and a rating of <1-1 according to the rust test in ISO 11007-1;

— no particular extreme pressure property;

— a worked penetration of 60 strokes at 25 °C between 220 mm and 250 1/10 mm, according to ISO 2137.