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Liquid petroleum products — Bio-lubricants — Criteria and requirements of bio-lubricants and bio-based lubricants

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National foreword

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European foreword

This document (EN 16807:2016) has been prepared by Technical Committee CEN/TC 19 “Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin”, the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2017, and conflicting national standards shall be withdrawn at the latest by April 2017.

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association. Mandate M/430 covers the development of European standards for bio-lubricants in relation to bio-based product aspects. It has been prepared by CEN/TC 19/WG 33 “Bio-Lubricants”, the secretariat of which is held by DIN.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

General technical specifications for the different types of lubricants, the test methods and criteria for performance are well defined compared to characteristics of the relatively new class of bio-lubricants.

Despite the great interest in 'environmentally compatible lubricants', the lack of standards and technical language describing these fluids and greases has impeded the growth of the market for these types of lubricants. Standards and definitions are only available for single groups of lubricants, for example for hydraulic fluids (ISO 15380 [1], some Ecolabels). However, a general, non-contentious and well-accepted description and definition including biodegradability, renewability and aquatic toxicity, consistently valid for all kinds of lubricants, still is missing.

The "bio-"prefix is often considered as a synonym of good for the environment, or in another situation, good for health. The prefix, when associated with lubricants, can be perceived by the consumers as an indication of biodegradability. In other words, a "bio-lubricant" is expected to biodegrade (to break down in the environment), needed for instance in case of leakages or technically intended losses.

In addition, the use of bio-based raw materials could be beneficial with reference to two current problems: fossil resources depletion and climate change. Today, regarding the latter issue, we have to manage the carbon in order to avoid its accumulation in the atmosphere. Efficient use of all available resources and responsible utilization of renewable carbon is a way to participate in this reduction; the prefix "bio" in this sense is taken as an indication of the biological circle.

Further detailed information is given in CEN/TR 16227 [2].

Lubricants are important materials which contribute significantly to efficient use of resources: thanks to their tailor-made properties they reduce energy losses and wear in machines and aggregates. The global manufacture of lubricants in all applications only uses a small part of the entire consumed mineral oil: in Europe, it makes up only about 1 %. The major fraction (>80 %) of the residual fossil material is used for energy production, predominantly for transportation and heating purposes. Besides crude oil, biomass is an additional raw material source for lubricants.

The currently available biomass is consumed in different segments: food and feed production, power and heat generation, biofuel production and industrial applications (e.g. production of paper, fine chemicals). Due to the limited capacity of ecosystems, the utilization efficiency of biomass and availability issues have to be addressed across the whole bio-economy landscape. The eco-efficiency in this competitive use (e.g. energetic use vs. manufacture of goods) should always be in focus.

Today it is mostly acknowledged that it would appear appropriate to use agricultural raw materials predominantly in a cascade of uses, instead of burning them directly in furnaces or engines. That would mean, for example, first producing a bio-lubricant from biomass: around 1 t to 2 t of bio-lubricants can be produced per hectare of agriculture land. The bio-lubricant thereby stores carbon dioxide in the form of vegetable carbon and removes it from atmosphere. It would be desirable to trap this carbon dioxide in the lubricant for as long as possible. Finally, after maximum utilization including recycling when achievable and appropriate, the lubricant can then be used either as energy source or – after re-refining – as downshifted base oil – to return the bound carbon to the natural cycle in the form of carbon dioxide.

In order to ensure responsible and environmentally conscious use of natural (fossil and renewable) resources, a clear and unambiguous terminology is of particular importance.

The approach which is published in this European Standard is focused on the view of the customer: *Are the referred criteria for "bio-lubricants" potentially provable for the formulated product?*

The statement of this document is: *Every announcement with regard to biodegradability, toxicity and renewability should be measurable through the final product in the hands of the customer.*

It has to be stated that this approach, based on testing of mixtures, is in principle complementary to the basics of the chemicals policy in Europe, which is focused on testing of single components and not on

testing of mixtures. Hence, adverse effects in humans and/or the environment are considered for specific chemicals but not for the mixture made of them. However, it has to be stated that the combination of well-tested single components in a mixture can generate synergistic or antagonistic effects. Even if biodegradability or bioaccumulation tests for mixtures maybe difficult to interpret, the view on the mixture is the view of the end-user. Thus, the approach of this standard is meaningful for business-to-consumer communication.

Adverse effects of single components are generally acknowledged and documented in the Safety Data Sheet for the mixture, according to the Classification, Labelling and Packaging Regulation [3].

Finally, this approach intends to enhance the reputation of "bio-lubricants" and the confidence of the customer in this product group.

The criteria and requirements for "bio-lubricants" published in this document are intended as horizontal requirements for all kinds of bio-based lubricants, and should be seen as minimum requirements compared to the European Ecolabel for Lubricants (EEL) [4].

The lubricants' base oils can be made from both biomass and fossil resources. Lubricants made from biomass can be rapidly, slowly, or not biodegradable; their base oils can be natural (unchanged renewable material) or synthetic (chemically modified biomass). Bio-lubricants can be a combination of both natural and synthetic base oils. All the different examples shown in Table 1 are present in the marketplace today and use the term "bio". This is a cause of concern as it can be the source of misleading information and confusion for the final consumers. The dissemination of confusing, ambiguous or misleading information should be prevented in order not to jeopardize the success of such schemes as well as the credibility of industry itself – this is the aim of this European Standard.

Table 1 — Examples for the use of the term "bio" with regard to lubricants

Origin of material	Biodegradability	Example	Occasional wording for the prefix "bio-"
Renewable	Rapidly biodegradable[a]	Rapeseed oil, Tri-methylol-propane-trioleate (TMP-O)	Biodegradable[a] and bio-based[b]
Non-renewable	Biodegradable[a]	Di-isotridecyl-adipate (DITA)	Biodegradable[a]
Renewable	Inherently or non biodegradable	Hydrocarbons from process "Biomass-to-Liquid" (BtL)	Bio-based[b]
Non-renewable	Non biodegradable	White oil for foodgrade lubricants	Biocompatible

[a] According to OECD 301[5].

[b] According to EN 16575.

NOTE In addition, consideration of soil dwelling organisms could be reflected in a future edition.

Even if in a more general approach "environmentally compatible lubricants" can be seen under additional aspects, up to a comprehensive Life Cycle Assessment (LCA), this European Standard focuses on the term bio-lubricant, which comprises requirements regarding biodegradability, aquatic toxicity, content of biomass and performance.

The initial issue of this standard is the qualification of the term “bio-based product” with regard to lubricants.

Since the bio-based content of a lubricant is not acknowledged as an adequate attribute per se, the combination with other environmentally relevant aspects like biodegradability and aquatic toxicity is obvious.

Similarly, the historical view on “bio-lubricants” only in relation to biodegradability shall be extended to aspects of renewable, biological resources.

Hence, this standard combines both the term “bio-based lubricant” and the term “bio-lubricant”, and to avoid misunderstandings, both terms are seen as equivalent according to this standard.

1 Scope

This European Standard specifies the term *bio-lubricant* and minimum requirements for all kinds of bio-lubricants and bio-based lubricants, while e.g. the EEL [4] refers to specific bio-lubricant families.

This European Standard also briefly describes relevant test method needs with respect to the characterization of bio-lubricants. It presents recommendation for related standards in the field of biodegradability, product functionality and the amount of different renewable raw materials and/or different bio-based contents used during manufacturing of such bio-lubricants forming one product group.

WARNING — Not all potential risks for the environment can be addressed by this standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CEN/TS 16640:2014, *Bio-based products - Determination of the bio based carbon content of products using the radiocarbon method*

EN 16575, *Bio-based products - Vocabulary*

EN ISO 3170, *Petroleum liquids - Manual sampling (ISO 3170)*

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

EN 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 7346-1)*

EN ISO 8692, *Water quality - Fresh water algal growth inhibition test with unicellular green algae (ISO 8692)*

EN ISO 9408, *Water quality - Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium by determination of oxygen demand in a closed respirometer (ISO 9408)*

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

EN ISO 10253, *Water quality - Marine algal growth inhibition test with Skeletonema costatum and Phaeodactylum tricornutum (ISO 10253)*

EN ISO 12922, *Lubricants, industrial oils and related products (class L) - Family H (Hydraulic systems) - Specifications for hydraulic fluids in categories HFAE, HFAS, HFB, HFC, HFDR and HFDU (ISO 12922)*

EN 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 14593)*

ISO 8068, *Lubricants, industrial oils and related products (class L) — Family T (Turbines) — Specification for lubricating oils for turbines*

ISO 10050, *Lubricants, industrial oils and related products (class L) — Family T (Turbines) — Specifications of triaryl phosphate ester turbine control fluids (category ISO-L-TCD)*

ISO 11158, *Lubricants, industrial oils and related products (class L) — Family H (hydraulic systems) — Specifications for categories HH, HL, HM, HV and HG*

ISO 12924, *Lubricants, industrial oils and related products (Class L) — Family X (Greases) — Specification*

ISO 12925-1, *Lubricants, industrial oils and related products (class L) — Family C (Gears) — Part 1: Specifications for lubricants for enclosed gear systems*

ISO/TS 12927, *Lubricants, industrial oils and related products (class L) — Family M (Metalworking) — Guidelines for establishing specifications*

ISO/TS 12928, *Lubricants, industrial oils and related products (class L) — Family R (Products for temporary protection against corrosion) - Guidelines for establishing specifications*

ISO 13738, *Lubricants, industrial oils and related products (class L) — Family E (Internal combustion engine oils) — Specifications for two-stroke-cycle gasoline engine oils (categories EGB, EGC and EGD)*

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

ISO 16221, *Water quality — Guidance for determination of biodegradability in the marine environment*

ISO 19378, *Lubricants, industrial oils and related products (class L) — Machine-tool lubricants — Categories and specifications*

ISO 24254, *Lubricants, industrial oils and related products (class L) — Family E (internal combustion engine oils) — Specifications for oils for use in four-stroke cycle motorcycle gasoline engines and associated drivetrains (categories EMA and EMB)*

EN 61039, *Classification of insulating liquids (IEC 61039)*

ASTM D6081, *Standard Practice for Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation*

ASTM D6866-12, *Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16575 and the following apply.

3.1
constituent
any chemical, material or substance of which a product is composed, including mixtures

4 Sampling

Samples shall be taken as described in EN ISO 3170 and/or in accordance with the requirements of national standards or regulations for the sampling of the product under test.

The purchaser may choose to sample and analyse each drum, barrel, tanker compartment or any type of container delivered to the end user.

5 Test methods

5.1 Biodegradation

Basically the biodegradability – the mostly connected wording for bio-lubricants – has been defined. The most commonly used test methods with regard to biodegradation are shown in Table 2; beyond these methods ASTM, DIN and other national procedures with more or less similar methods and restrictions do exist.

For requirements see 6.3.

Table 2 — Test methods for testing the biodegradation of lubricants

Test method	Corresponding OECD test method	Short description – relation to other test methods
EN ISO 9439	OECD 301B [5]	"Modified Sturm test", aerobic degradation, ultimate biodegradation (for non water soluble substances)
EN ISO 14593	OECD 310 [6]	CO_2 -Headspace Test (for non water soluble substances)
ISO 16221	OECD 306 [7]	Biodegradation in Seawater (for non water soluble substances, only to be used for marine environments)
EN ISO 9408	OECD 301F [5]	Manometric respirometric test (for water soluble substances)

NOTE 1 All actual ecolabels, regulations and recommendations are working with the respective ISO or OECD test methods described in Table 2, which include also a limit for "ready biodegradation".

NOTE 2 Claims of biodegradability in other environments (e.g. landfill) currently lack appropriate standards although development work is ongoing.

NOTE 3 Precision information is currently under development.

5.2 Ecotoxicity

For bio-lubricants, toxicological criteria are to be considered. The aim is to protect life in various environments, especially in water (aquatic) and on land (non-aquatic area). Table 3 shows test methods of importance, especially used in the ecolabelling systems. It has to be noted that current EU legislation requests permission for the execution of some of these test methods.

For mixtures like lubricants the CLP Regulation 1272/2008/EC [3] (Classification, Labelling, and Packaging Regulation) is of main importance for assessing the hazard potential, whereas the test methods are detailed in Regulation 440/2008/EC [8]. As a consequence, lubricants not meeting the criteria in 6.4 shall be labelled as "Dangerous for the Environment" (DfE) and may be labelled with the hazard symbol "dead fish/dead tree" (symbol GHS 09), based on the amount of DfE classified components they contain and/or their intrinsic hazard properties.

To avoid this negative labelling for bio-lubricants special toxicity limits are provided, the criteria of 6.4 are required for bio-lubricants.

According to the CLP the health and environmental hazards of a mixture may be evaluated by:

1) either a "conventional" (or "calculation") test method, with limits for single components, or

2) by testing the mixture using experimental test methods, e.g. relevant ISO methods.

Table 3 — Test methods for testing the aquatic toxicity of (not water soluble) lubricants

Test method	Corresponding OECD test method	Short description – relation to other test methods
EN ISO 8692	OECD 201 [9]	A fresh water algal growth inhibition test method with unicellular green algae for aquatic systems (measurement of chlorophyll-fluorescence and determination of EC_{10} and EC_{50} values)
EN ISO 10253		A marine algal growth inhibition test with Skeletonema costatum and Phaeodactylum tricornutum; only to be used for marine environments
EN ISO 6341	OECD 202 [10]	This acute toxicity test method concerning the aquatic environment, determines the inhibition of the mobility of Daphnia magna straus (water flea). Test results are EC_{10}, EC_{20} and EC_{50} values.
ISO 14669		Similar to the above, determines the acute lethal toxicity to marine copepods (Copepoda, Crustacea); only to be used for marine environments
EN ISO 7346-1	OECD 203 [11]	Determination of the acute lethal toxicity of substances to a fresh-water fish, performed on the Goldorfe (Leuciscus idus). Static method. Test method results are the LC_0, LC_{50} and LC_{100} values.

In general, classification derived using test data of the finished product will override those given by the "calculation method", but there are a number of exceptions to this. Any mixture containing more than the specified amount of a component, which is classified as a carcinogen, mutagen or reproductive toxicant, shall be classified using the conventional test method.

Following the test method shown in Table 3, for determination of the acute aquatic toxicity by testing the mixture, the test methods are to be carried out on all three species (i.e. algae, daphnia and fish) according to ISO methods with the limits as in 6.4, unless the highest hazard classification relating to acute aquatic toxicity has been assigned to the mixture after testing on one of the species. A mixture confirming to the requirements set in 6.4 for all three species is considered not to be dangerous for the environment for the purpose of this standard, even if it would be labelled as such by the calculation method.

To reduce testing on vertebrates it is optional for the producer of the bio-lubricant to use the "conventional" (or "calculation") test method where adequate data exists for all intentionally added components present at ≥ 0,1wt% in the finished lubricant.

The CLP Regulation will supersede the Dangerous Preparation Directive (1999/45/EC [12]). From 1 June 2015, substances and mixtures (e.g. finished lubricants) should be classified, labelled and packaged according to CLP [3].

5.3 Bio-based carbon content

For the intention of this standard it is important to distinguish bio-based products from non-bio-based products. As bio-based products can be made with a mix of bio-based and non-bio-based (e.g. from fossil

oil) components, the bio-based content criteria is of high importance. Test methods used at present for that matter are mostly based on ^{14}C measurement as specified in ASTM D 6866-12 and CEN/TS 16640.

For special applications such as solid recovered fuels [13, 14] or plastics [15] dedicated approaches are available. However, these methods have not yet been applied to the whole range of bio-based products ("horizontal standard"), such as liquids and assembled products. In Europe, horizontal methods are currently being developed mainly using ^{14}C measurement as specified in ASTM D 6866-12 and CEN/TS 16640 (see Annex A).

Effectively, with ASTM D 6866-12 and CEN/TS 16640:2014 only the content of ^{14}C is measured. In contrast, no standard is actually known for the determination of the renewable content of oxygen, nitrogen or hydrogen. Hence, for the time being the question of renewable raw material has to be reduced to "bio-based carbon content".

NOTE All of these test methods relate to the origin of the carbon content of the final product. They do not include any consideration of the origin of the energy used in production, distribution and disposal of the material, which requires a full life cycle analysis if the true environmental impact of any material is to be assessed. More energy can be needed to grow and harvest biomass than to process oil. These effects only can be assessed by an overall LCA.

The bio-based carbon content may be approximated by a calculation method, as laid down in 2011/381/EU [3]. Due to the approach of this European Standard that every announcement with regard to biodegradability, toxicity and renewability should be measurable through the final product in hands of the customer, it is obvious that the calculation method can only give indications in regard to bio-based carbon content; the final judgement has to be done via a ^{14}C method.

5.4 Fit for purpose / Fit for use

Judged as usable in a specific application, according to national or international standards (see e.g. Annex B) or agreed between lubricant manufacturer and end-user.

Even if in this European Standard the environmental aspects of lubricants are predominant, from the end-user's point of view the performance is most crucial for the technical application. However, the performance can only be specified individually for each application; a horizontal standard covering all lubricant families is not possible. In this regard, Annex B contains well accepted national or international standards, which are required for the technical qualification for both the conventional and the bio-based lubricants.

In this sense the term 'Fit for purpose' describes the legal responsibility of the manufacturer, as well as the responsibility of the user. In cases where specific (international) standards are available and accepted, those criteria should be used; best example is the International Standard ISO 15380 for environmentally acceptable hydraulic fluids.

6 Criteria and minimum requirements for ´Bio-Lubricants' and ´Bio-based Lubricants´

6.1 General

In this document, the term "bio-lubricant" as well as the term "bio-based lubricant" refer to the four criteria namely bio-based carbon content, biodegradability, ecotoxicity and performance. To avoid ambiguity, wherever the claim for "bio-lubricants" or "bio-based lubricants" is desired or requested, each of the following requirements have to be fulfilled.

The use of (potentially) bio-accumulative substances in bio-lubricants and bio-based lubricants should be minimized whenever possible. Very persistent and very bio-accumulative (vPvB) substances shall be avoided.

NOTE Appropriate bioaccumulation testing methods on fully formulated products are currently lacking from existing standards. Such tests are expected to be developed and addressed in the standard by the next revision process.

6.2 Bio-based content

The bio-based content according to this standard is synonymous to the bio-based carbon content and has to amount to at least 25 % according to ASTM D 6866-12 (^{14}C analysis).

6.3 Biodegradability

The biodegradability of the finished lubricant shall be:

— for oils ≥ 60 % according to either EN ISO 14593 or EN ISO 9439 or ISO 16221 or EN ISO 9408;

— for lubricating greases ≥ 50 % according to either EN ISO 14593 or EN ISO 9439 or ISO 16221 or EN ISO 9408.

6.4 Ecotoxicity

The finished bio-lubricant should not be labelled as “Dangerous to the environment”. This shall be proven by testing according to:

— EN ISO 8692 (fresh water algal test) or EN ISO 10253 (marine algal test) — EC50 > 100 mg/l, and

— EN ISO 6341 (Daphnia) or ISO 14669 (marine copepods) — EC50 > 100 mg/l, and

— EN ISO 7346-1 (fish) — LC50 > 100 mg/l

Water soluble fluids shall be tested according to the test methods stated. Poorly water soluble fluids shall be prepared by using adapted fractions according to ASTM D 6081.

6.5 Performance

The lubricant shall meet the specification agreed upon by the manufacturer/supplier and the customer – see 5.4.

Annex A
(informative)

Test methods for determining ^{14}C content

The known test methods for determination of ^{14}C content are listed in Table A.1.

Table A.1 — Test methods for determination ^{14}C content

Liquid scintillation-counter (LSC) Proportional scintillation method (PSM)	**Betaionisation (BI)**	**Accelerator Mass Spectroscopy (AMS)**
ASTM D 6866–12, Method C	ASTM D 6866–12, Method A	ASTM D 6866–12, Method B
CEN/TS 16640:2014, Annex C	CEN/TS 16640:2014, Annex D	CEN/TS 16640:2014, Annex E
CEN/TS 16137:2011, Annex B [15]	CEN/TS 16137:2011, Annex C	CEN/TS 16137:2011, Annex D
EN 15440:2011, C.8 [13]	EN 15440:2011, C.9	EN 15440:2011, C.10
EN ISO 13833:2013, Annex B [16]	EN ISO 13833:2013, Annex C	EN ISO 13833:2013, Annex A

Annex B
(normative)

Bio-lubricants - groups of application

All parts of ISO 6743 [17] establish the general classification system, which applies to lubricants, industrial oils and related products called class L. Within class L 18 families of products are defined to cover all applications for which lubricants are used. Not all families have been issued. The parts 16, 17 and 18 of ISO 6743 are under preparation. Some of these 18 families and some of their subdivisions are shown below, mainly those product groups with some relevance to bio-lubricants. Table B.1 summarizes nearly all application types of lubricants and their international specifications, of which only two (ISO 15380, ISO 8068) contain explicit requirements with regard to toxicity and biodegradability. National specifications are not covered in this table.

Table B.1 — Lubricants, as delivered – families and specifications

Product group	Main use today	Family	International Specification
Industrial	Hydraulic oils	H	ISO 11158 EN ISO 12922[a] ISO 15380[b]
	Air compressor oils	D	
	Gas compressor oils	D	
	Industrial gear oils	C	ISO 12925-1
	Slideway oils	G	ISO 19378
	Bearing and circulating system oils	F	
	Refrigerator compressor oils	D	
	Steam and gas turbine oils	T	ISO 8068[b] ISO 10050[c]
	Machine oils	L	ISO 19378
	Insulating liquids	N	EN 61039
	Concrete release agents – oil types		
	Concrete release agents – emulsion types		
	Chainsaw oils	A	

Product group	Main use today	Family	International Specification
Metalworking	Cutting fluids – water-miscible	M	ISO/TS 12927
	Cutting fluids – not water-miscible	M	ISO/TS 12927
	Forming oils	M	ISO/TS 12927
	Rust preventives	M	ISO/TS 12927
	Quenching oils	M	ISO/TS 12927
Automotive	Engine oils petrol (gasoline) engine oils diesel engine oils 2-stroke engine oils gas turbine engine oils	E	ISO 24254 ISO 13738
	Automotive gear oils manual transmission oils automatic transmission fluids		
	Brake fluids		
	Mobile hydraulic fluids		
	Air filter oils		
	Tractor (one lubricant for all systems) Universal Tractor Transmission Oil – UTTO Super Tractor Oil Universal – STOU		
	Crosshead cylinder oils		
	Crosshead crankcase oils		
	Trunk piston engine oils		

	Stern tube lubricants		
Temporary protection against corrosion		R	ISO/TS 12928

Product group	Main use today	Family	International Specification
Greases	Roller bearings	X	ISO 12924
	Cars, trucks, construction vehicles	X	ISO 12924
	Steel mill	X	ISO 12924
	Mining	X	ISO 12924
	Railroad, railway	X	ISO 12924
	Gears	X	ISO 12924
	Food-grade applications	X	ISO 12924
	Textile machines	X	ISO 12924

a Incl. HFDU ester based fire-resistant hydraulic fluids.

b Incl. toxicity requirements

c Only for triaryl phosphate ester turbine control fluids

Bibliography

[1] ISO 15380, *Lubricants, industrial oils and related products (class L) — Family H (Hydraulic systems) — Specifications for categories HETG, HEPG, HEES and HEPR*

[2] CEN/TR 16227, *Liquid petroleum products - Bio-lubricants - Recommendation for terminology and characterisation of bio-lubricants and bio-based lubricants*

[3]. 1272/2008/EC. *Regulation of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006OJ EU*. 2008, **353** (L) pp. 1–1355

[4] 2011/381/EU, *Commission Decision of 24 June 2011 on establishing the ecological criteria for the award of the EU Ecolabel to lubricants* (notified under document C(2011) 4447)

[5] OECD 301, *Ready Biodegradability*

[6] OECD. 310, Ready Biodegradability - CO2 in sealed vessels (Headspace Test)

[7] OECD. 306, Biodegradability in Seawater

[8] 440/2008/EC, *Commission Regulation (EC) No 440/2008 of 30 May 2008 laying down test methods pursuant to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)*

[9] OECD. 201, Freshwater Alga and Cyanobacteria, Growth Inhibition Test

[10] OECD. 202, Daphnia sp. Acute Immobilisation Test

[11] OECD. 203, Fish, Acute Toxicity Test

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