SAE International

INDUSTRIAL LUBRICANT STANDARD

SAE MS1011 MAR2013

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Superseding MS1011 JAN2002

Lubricants, Industrial Oils and Related Products - Type X (Greases) - Specification

RATIONALE

The revision of SAE MS1011 was necessary to reflect changes to test limits, changes to test methods and additional standards that have been incorporated since SAE MS1011 was originally released in 2002.

FOREWORD

The Society of Automotive Engineers (SAE) Industrial Lubricants Committee has developed a number of industrial, non-production, lubricant performance specifications.

The purpose of these voluntary SAE documents is to:

a. Define minimum performance requirements for industrial lubricants, where tests are available.

b. Provide lubricant suppliers with performance targets for key industrial lubricants.

c. Promote the availability of these lubricants to member companies and others that may wish to use these specifications.

d. Provide a user friendly classification system using common test standards and properties.

ISO Standard 6743 - Lubricants, industrial oils and related products (class L) - Classification is the foundation for these documents.

a. Performance properties, requirements, and test procedures are specified.

b. For information, equivalent ISO, DIN, CEN, BSI, ASTM, AFNOR, CETOP, VDMA, and EI/IP test methods are referenced.[1]

See References, Section 2

[1]International Standards Organization (ISO)Deutsches Institut fur Normung e. V. (DIN)European Committee for Standardization (CEN)American Society for Testing and Materials (ASTM)Association Francaise de Normalisation (AFNOR) The Energy Institute (EI), formerly The Institute of Petroleum (IP) Note: Now combined with BSI British Standards Institution (BSI), BS 2000: XXX where XXX is the corresponding IP number European Committee on Oil Hydraulic Pneumatic Committee (CETOP)German Association of Machine and Plant Construction (VDMA)

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http://www.sae.org/technical/standards/MS1011_201303

Industrial lubricant classifications targeted:

a. Lubricants, Industrial Oils and Related Products - Classification (SAE MS1000)

b. General purpose and total loss lubricants (SAE MS1001)

c. Gear oils (SAE MS1002)

d. Compressor oils (MS1003)

e. Hydraulic fluids (SAE MS1004)

f. Fire resistant hydraulic fluids (SAE MS1005)

g. Lubricants for spindle bearings and associated clutches (SAE MS1006)

h. Slideway Lubricants – Specification (SAE MS1007)

i. Metal removal fluids (SAE MS1008)

j. Pneumatic Tool Oils (SAE MS1009)

k. Turbine Oils (SAE MS1010)

l. Lubricating greases (SAE MS1011)

NOTE: Environmental and/or health and safety regulations will present additional specifications to these standards. Contact individual end users regarding requirements in these areas.

NOTE: There can be issues related to the quality of industrial lubricants that fall outside of the scope of this specification.

1. SCOPE

The greases have been classified according to the operating conditions under which they are used, because the versatile nature of greases makes it impractical to classify them according to end use. It will therefore be necessary to consult the supplier to be certain that the grease can be used in; for example, rolling bearings or pumped supply systems, and also concerning the compatibility of products (see Remarks in Table 1).

NOTE: In this classification, a grease cannot have more than one symbol. This symbol should correspond to the most severe conditions of temperature, water contamination and load in which the grease can be used.

TABLE 1 - RECOMMENDATIONS FOR THE CHOICE OF LUBRICANTS FOR MACHINE TOOLS (FROM ISO TR3498)

Symbol	General application	Particular application	Product type and/or performance requirements	Category symbol	Examples of applications	Remarks
X	Applications requiring grease	Multi-purpose grease	Greases with improved anti-oxidation and anti-corrosion properties	XBCEA 00 XBCEA 0 XBCEA 1[2] XBCEA 2[(1)] XBCEA 3[(1)]	Plain rolling bearings, open gears and general greasing of miscellaneous parts	Grease XBCEA 1 is used in centralized systems, while greases XBCEA 2 and XBCEA 3 are dispensed preferably by cup or hand gun. The equipment manufacturer should identify the grease used for the initial filling of each item to ensure that the grease subsequently introduced is compatible with it.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 Referenced AFNOR, BS, CEN, DIN, IP, and VDMA Standard hardcopies are available from the SAI Global Website (http://www.saiglobal.com) SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE MS1000 Lubricants, Industrial Oils and Related Products - Classification

SAE MS1002 Lubricants, Industrial Oils, and Related Products Type C (Gears) Specification

SAE MS1003 Lubricants, Industrial Oils and Related Products Type D (Compressor Oils) Specification

SAE MS1004 Lubricants, Industrial Oils and Related Products Type H (Hydraulic Fluids) - Specification

SAE MS1005 Lubricants, Industrial Oils and Related Products Type HF Fire-Resistant Hydraulic Fluids - Specification

SAE MS1006 Lubricants, Industrial Oils, and Related Products Type F Lubricant for Spindle Bearings, and Associated Clutches - Specification

SAE MS1007 Lubricants, Industrial Oils, and Related Products Type G Slideway Lubricants –Specification

SAE MS1008 Lubricants, Industrial Oils and Related Products Type M (Metal Removal Fluids) - Specification

SAE MS1009 Lubricants, Industrial Oils, and Related Products Type P Pneumatic Tool Oils – Specification

SAE MS1010 Lubricants, Industrial Oils, and Related Products Type T Turbine Oils - Specification

SAE MS1011 Lubricants, Industrial Oils and Related Products Type X (Greases) - Specification

[2]This designated grease in Grades 1, 2, and 3 is exclusively recommended.

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

ASTM D 92 Test Method for Flash and Fire Points by Cleveland Open Cup

ASTM D 95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation

ASTM D 128 Standard Test Methods for Analysis of Lubricating Grease

ASTM D 217 Test Methods for Cone Penetration of Lubricating Grease

ASTM D 566 Test Method for Dropping Point of Lubricating Grease

ASTM D 611 Test Methods for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents

ASTM D 942 Test Method for Oxidation Stability of Lubricating Greases by the Oxygen Bomb Method

ASTM D 1264 Test Method for Water Washout Characteristics of Lubricating Greases

ASTM D 1742 Test Method for Oil Separation from Lubricating Grease during Storage

ASTM D 1743 Test Method for Corrosion Preventive Properties of Lubricating Greases

ASTM D 1744 Test Method for Determination of Water in Liquid Petroleum Products by Karl Fischer Reagent

ASTM D 2140 Test Method for Carbon-Type Composition of Insulating Oils of Petroleum Origin

ASTM D 2265 Test Method for Dropping Point of Lubricating Grease Over Wide- Temperature Range

ASTM D 2266 Test Method for Wear Preventive Characteristics of Lubricating Grease (Four-Ball Method)

ASTM D 2422 Classification of Industrial Fluid Lubricants by Viscosity System

ASTM D 2509 Standard Test Method for Measurement of Load-Carrying Capacity of Lubricating Grease (Timken Method)

ASTM D 2595 Test Method for Evaporation Loss of Lubricating Greases over Wide-Temperature Range

ASTM D 2596 Test Method for Measurement of Extreme-Pressure Properties of Lubricating Grease (Four-Ball Method)

ASTM D 3238 Method for Calculation of Carbon Distribution and Structural Group Analysis of Petroleum Oils by the N-D-M Method

ASTM D 3527 Test Method for Life Performance of Automotive Wheel Bearing Grease

ASTM D 4048 Test Method for Detection of Copper Corrosion from Lubricating Grease

ASTM D 4290 Test Method for Determining the Leakage Tendencies of Automotive Wheel Bearing Grease under Accelerated Conditions

ASTM D 4425 Test Method for Oil Separation from Lubricating Grease by Centrifuging (Koppers Method)

ASTM E 1687 Standard Test Method for Determining Carcinogenic Potential of Virgin Base Oils in Metalworking Fluids

2.1.3 BS Publications

Available from SAI as referenced in 2.1.

BS 4231 Classification for Viscosity Grades of Industrial Liquid Lubricants

BS 4385 Methods for Determination of Water in Crude Petroleum, Petroleum Products and Bituminous Materials by Distillation (Superseded by ISO 9029)

2.1.4 DIN Publications

Available from Deutsches Institut für Normung e.V., Burggrafenstrasse 6, 10787 Berlin, Germany, www.din.de\

DIN 51 350/4 Testing of Lubricants - Testing by the Shell Four-Ball Tester; Determination of Welding Load of Consistent Lubricants

DIN 51 350/5 Testing of Lubricants - Testing by the Shell Four-Ball Tester; Determination of Wear Characteristics of Consistent Lubricants

DIN 51 519 Lubricants; ISO Viscosity Classification for Industrial Liquid Lubricants

DIN 51 775 Testing of Mineral Oil Hydrocarbons; Determination of Aniline Point & Mixed Aniline Point of Bright Mineral Oil Hydrocarbons (SUPERSEDED BY ISO 2977)

DIN 51 787 Testing of Mineral Oil Hydrocarbons; Determination of Aniline Point and Mixed Aniline Point of Dark Mineral Oil Hydrocarbons (SUPERSEDED BY ISO 2977)

DIN 51 802 Testing Lubricating Greases for Their Corrosion-Inhibiting Properties by SKF Emcor Method

DIN 51 803 Testing of Lubricants; Determination of Ash in Lubricating Greases

DIN 51 805 Testing of Lubricants; Determination of Flow Pressure of Lubricating Greases, Kesternich Method

DIN 51 806 Testing of Lubricants; Determination of Dropping Point of Greases

DIN 51 807/2 Testing of Lubricants; Test On the Behavior of Greases in the Presence of Water under Dynamic Tests

DIN 51 808 Testing of Lubricants; Determination of Oxidation Stability of Greases; Oxygen Method

DIN 51 811 Testing Of Lubricants; Testing of Corrosiveness to Copper of Greases; Copper Strip Tarnish Test

DIN 51 813 Determination of Solid Matter Content of Lubricating Greases (Particle Sizes above 25 Um)

DIN 51 817 Determination of Oil Separation from Lubricating Grease under Static Conditions

DIN 51 818 Lubricants; Consistency Classification of Lubricating Greases; NLGI Grades

2.1.5 Energy Institute (EI), formerlyIP Publications

Available from SAI as referenced in 2.1.

EI/IP 2	Petroleum Products and Hydrocarbon Solvents - Determination of Aniline Point and Mixed Aniline Point
EI/IP 5	Petroleum Products - Determination of Ash
EI/IP 36	Determination of Open Flash and Fire Point - Cleveland Method
EI/IP 37	Determination of Acidity and Alkalinity of Lubricating Grease
EI/IP 50	Test Methods for Cone Penetration of Lubricating Grease
EI/IP 74	Determination of Water Content of Petroleum Products - Distillation Method
EI/IP 112	Determination of Corrosiveness to Copper of Lubricating Grease - Copper Strip Method
EI/IP 121	Determination of Oil Separation Characteristics of Lubricating Grease - Pressure Filtration Method
EI/IP 132	Petroleum Products - Lubricating Grease - Determination of Dropping Point
EI/IP 134	Determination of Foreign Particulate Matter in Lubricating Grease - Microscopic Counting Method (CANCELLED)
EI/IP 142	Oxidation Stability of Lubricating Grease - Oxygen Bomb Method
EI/IP 215	Determination of Water Washout Characteristics of Lubricating Grease
EI/IP 220	Petroleum Products and Lubricants - Determination of Rust-Prevention Characteristics of Lubricating Greases
EI/IP 226	Petroleum Products - Calculation of Viscosity Index from Kinematic Viscosity
EI/IP 239	Determination of Extreme Pressure and Antiwear Properties of Lubricants - Four Ball Machine Method
EI/IP 326	Determination of Extreme Pressure Properties of Grease - Timken Method

2.1.6 EPA Publications

Standard test methods of the U. S. Environmental Protection Agency. SW-846 Methods are available on-line (Website: http://www.epa.gov/epaoswer/hazwaste/test/8xxx.htm). Method 24 available in the Code of Federal Regulations in 40 CFR, Part 60, Appendix A)

EPA SW 846, Method 8082 Polychlorinated Biphenyls (PCB's) By Gas Chromatography

EPA SW 846, Method 8121 Chlorinated Hydrocarbons by Gas Chromatography: Capillary Column Technique

EPA SW 846, Method 8270C Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry

2.1.7 Federal Test Method Publications

Standard test methods of the U. S. Department of Defense. FTM methods are available on-line (Website: http://stinet.dtic.mil/). Department of Defense Index of Specifications and Standards (DODISS) fielded search. Enter FED-STD-791C in "DODISS ID NUMBER" search field. Available in PDF format (Acrobat Reader Software required).

FTM 791 3005.4 Dirt Content of Grease; Federal Test Method Standard 791C Lubricants, Liquid Fuels and Related Products

2.1.8 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 2137 Petroleum products - Lubricating grease and petrolatum - Determination of cone penetration

ISO 2160 Petroleum products - Corrosiveness to copper - copper strip test

ISO 2176 Petroleum products - Lubricating grease and petrolatum - Determination of dropping point

ISO 2592 Petroleum products - Determination of flash and fire points - Cleveland open cup method

ISO 2977 Petroleum products and hydrocarbon solvents - Determination of aniline point and mixed aniline point

ISO 3448 Industrial liquid lubricants - ISO viscosity classification

ISO TR 3498 Lubricants, industrial oils and related products (class L) - Recommendations for the choice of lubricants for machine tools

ISO 3733 Petroleum products and bituminous materials - Determination of water - Distillation method

ISO 6743/0 Lubricants, industrial oils and related products (Class L) - Classification - General

ISO 8681 Petroleum products and lubricants - Method of classification - Definition of classes

3. CONCEPT

The lubricants defined by this specification apply to categories of greases used for lubrication of equipment, components of machines, etc.; NLGI grades 000, 00, 0, 1, 2, and 3. NLGI grades 4, 5, and 6 are not included.

3.1 Explanation of symbols used

3.1.1 The detailed classification of family X is based on the operating conditions of grease use.

3.1.2 In accordance with ISO 8681, the complete designation of a grease includes:

a. The category of grease constituted by a group of five letters where each letter and the order in which it is written has a particular significance: See Tables 2 and 3.

b. The letter X for the family grease,

c. The lower operating temperature (symbol 1),

d. The upper operating temperature (symbol 2),

e. The ability of the grease to provide satisfactory lubrication in water contamination conditions and to provide the level of anti-rust protection described in Table 4 (symbol 3),

f. The ability of the grease to lubricate in the presence of high or low loads (symbol 4),

g. The NLGI consistency number 2) (see Table 5) of the grease corresponding to the measured penetration level according to ISO 2137.

h. For the definition of the NLGI consistency number, see ISO 6743-0

3.1.3 In this classification system, products are designated in a uniform manner, each letter having a significance of its own. It is therefore imperative that the order of writing shown in Table 1 be used.

For instance, a grease for use under the following operating conditions:

a. Lower operating temperature: –20 °C

b. Upper operating temperature: +120 °C

c. Water wash: Static moisture (environment); protect in the presence of fresh water (anti- rust protection)

d. Low loads: not requiring EP properties

e. NLGI consistency number: 1

Will have the designation: XBCEA-1.

3.2 Detailed classification

a. The detailed classification is shown in Table 3.

TABLE 2 - ORDER OF LETTERS FOR DESIGNATION OF GREASES

X	Symbol 1	Symbol 2	Symbol 3	Symbol 4	NLGI number
Family greases	Lower operating temperature	Upper operating temperature	Water contamination	EP	Consistency

The NLGI - National Lubricating Grease Institute “Lubricating Grease Guide” (Third Edition) has been used as a reference in this document.

TABLE 3 – CLASSIFICATION OF GREASES

Code Letter	General Application	Application Requirements Range of Operating Temperatures Lower Temperatures [1] °C	Application Requirements Range of Operating Temperatures Symbol 1	Application Requirements Range of Operating Temperatures Upper Temperature [2] °C	Application Requirements Range of Operating Temperatures Symbol 2	Application Requirements Water Contamination	Application Requirements Symbol 3	Application Requirements Load (EP)	Application Requirements Symbol 4	Application Requirements Consistency	Designation	Remarks
X	Lubrication requiring grease	0	A	60 90 120 140 160 180 >180	A B C D E F G	Ability of the grease to provide satisfactory lubrication in water contamination conditions, and to provide the level of anti-rust protection described in Table 4	A B C D E F G H I	Ability of the grease to lubricate in the presence of high or low loads. Symbol A for applications not requiring EP grease and symbol B for applications requiring EP grade	A B	Associate the appropriate NLGI consistency number, as shown in Table 5, with the other symbols	The designation of a grease is made by associating symbol X with other symbols 1, 2, 3, and 4 and with the NLGI consistency number as illustrated in 1.1.3	Warning: It should not be assumed that greases falling within this classification are mutually compatible. Since lack of compatibility could result in a severe reduction in the performance level of grease, the grease suppliers should be consulted before allowing contact between different products
		-20	B	60 90 120 140 160 180 >180	A B C D E F G							
		-30	C	60 90 120 140 160 180 >180	A B C D E F G							
		-40	D	60 90 120 140 160 180 >180	A B C D E F G							
		< -40	E	60 90 120 140 160 180 >180	A B C D E F G							

1) The lowest temperature experienced while starting or running the equipment or while pumping the grease.

2) The highest temperature of the lubricated component when in service.

TABLE 4 - LEVEL OF ANTI-RUST PROTECTION

Environmental conditions[3]	Anti-rust protection[4]	Symbol 3
L	L	A
L	M	B
L	H	C
M	L	D
M	M	E
M	H	F
H	L	G
H	M	H
H	H	I

TABLE 5 - NLGI CONSISTENCY NUMBER

NLGI Consistency No.	ASTM Worked Penetration at 25 °C
000	445 to 475
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

4. REQUIREMENTS AND TESTING

See Tables 6 and 7.

Type X lubricating greases shall be compatible with all materials normally encountered, including elastomer seals, coatings, metallic and non-metallic components, etc.

[3] L dryM static moistureH water wash
[4] L no protection M protect in the presence of fresh-water H protect in the presence of salt water

TABLE 6 - TYPE X (GREASES)

Property	Requirements						Testing as specified in ISO	Technical Equivalent Standards DIN	Technical Equivalent Standards ASTM	Technical Equivalent Standards EI/IP/BS
Base Oil Specification:										
Paraffinic, Naphthenic, Aromatic Content	Report								D 3238 D 2140	
Total PNA, ppm	100 Max.									EPA SW-846 TN 8270C
Total PCB, ppm	Not Detectable									EPA SW-846 TN 8082
Total Organic Halogens, ppm	5 Max.									EPA SW-846 TN 8121
Ames Mutagenicity: Fold Increase Mutagenicity Index Mutagen.Potency Index	 Report Max Report								E 1687	
NLGI grade	000	00	0	1	2	3		51 818		
Worked penetration 60 strokes @ 25 °C 10 000 strokes @ 25 °C	 445 - 475 430 - 490	 400 - 430 385 - 445	 355 - 385 340 - 400	 310 - 340 295 - 355	 265 - 295 250 - 310	 220 - 250 205 - 265	2137	DIN ISO 2137	D 217	EI/IP 50
Dropping point °C			≥ 175	≥ 175	≥ 175	≥ 175	2176	DIN ISO 2176 51 806	D 566 D 2265	EI/IP 132
Lower operating temperature °C	To be reported by supplier							51 805		
Water washout at 79 °C	NA	NA	NA	≤ 8%	≤ 8%	≤ 8%		51 807 PART 2	D 1264	EI/IP 215
Rust preventing characteristics	Pass							51 802	D 1743	EI/IP 220

Property	Requirements						Testing as specified in ISO	Technical Equivalent Standards DIN	Technical Equivalent Standards ASTM	Technical Equivalent Standards EI/IP/BS
Base oil flash point °C	≥ 190						2592	DIN ISO 2592	D 92	EI/IP 36
Water content, expressed as a proportion by mass, in %	Report						3733	DIN ISO 3733	D 95 D 1744	EI/IP 74 BS 4385
NLGI grade	000	00	0	1	2	3	ISO	DIN	ASTM	EI/IP/BS
Corrosive effect on copper 3 h at 100 °C	≤ 1b						2160	51 811	D 4048	EI/IP 112
Pressure separation	NA	NA	Report	0.5 – 5%	0.5 – 5%	0.5 – 5%		51 817	D 1742	EI/IP 121
Oxidation stability, pressure drop after 100 h	≤ 35 kPa							51 808	D 942	EI/IP 142
ISO Viscosity of base oils	Report						3448	51 519	D 2422	BS 4231 EI/IP 226
Emcor rust test	≤ #1 rating							51 802		EI/IP 220
Evaporation loss	≤ 3%								D 2595	
Oil separation	NA	NA	NA	≤ 10%	≤ 10%	≤ 10%			D 4290	
Four ball EP Load wear index, kg Weld load, kg	 ≥ 40 ≥ 250							51 350	D 2596	
Timken OK load, kg	≥ 18								D 2509	EI/IP 326
Four ball wear test (20 kg load) wear scar diameter, mm	≤ 0.8mm							51 350 Part 4/5	D 2266	EI/IP 239