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भारतीय मानक मसौदा

ऑटोमोटिव गियर और अक्षदण्ड स्नेहक, बहुउद्देशीय (अत्यधिक दबाव) — विशिष्टि

(IS 1118 *का तीसरा पुनरीक्षण*)

Draft Indian Standards

AUTOMOTIVE GEAR AND AXLE LUBRICANTS, MULTIPURPOSE (EXTREME PRESSURE) — SPECIFICATION

(*Third Revision of* IS 1118)

(ICS No. 75.100)

Lubricants and their related products Sectional Committee, PCD 25	Last date for receipt of comment is **26 January 2025**

FOREWORD

(*Formal clauses will be added later*)

This standard was originally published in 1957 covering gear lubricants based on the prevailing U.S. Military Specification MIL-L-2105 and the U.K. Military of Supply Specification CS 2758. The standard was first revised in 1992 to align with the then prevailing U.S. Military, U.K. Military of Supply, and API standards. These oils were classified as extreme pressure (EP) oils under two different performance levels, which correspond to different applications, i.e., a) EP Type GL-4 with equivalent performance level of MIL-L-2105B/API GL-4/ CS 3000A, and b) EP Type GL-5 with equivalent performance level of MIL-L-2105D/API GL-5/ CS 3000B.

Time to time, the U.S. Military, U. K. Military, and API GL-5 specifications underwent considerable changes. The key changes based on the developments in gear oil specifications were included in earlier revisions.

IS 1118-Standard Type	**Global Equivalent Performance**
EP Type API GL-4	API GL-4 (50 percent treat level of API GL-5)
EP Type API GL-5	API GL-5 (ASTM D7450)

As performance test facilities for qualifying EP type GL-4 and EP type GL-5 oils were not available in India, for the purpose of qualifying oils against EP type GL-4, facilities available in the approved overseas laboratories were utilized. However, for guaranteeing the quality,

only oils having half the dosage of the GL-5 approved EP type API GL5 additive package (i.e. 50 percent) were allowed as qualified EP Type API GL4 oils.

Performance tests to qualify API GL-5 were also upgraded from ASTM STP 512A to ASTM D7450. For newer additives and lubricants, the EP type API GL5 qualification needs to be obtained by running all the tests as per ASTM D 7450. The previous qualified lubricants must have historical data as per ASTM STP 512A/STP 512. All the ASTM qualification tests must be run or must have been run at a qualified laboratory that has been calibrated and being monitored by the ASTM Test Monitoring Centre. This is to ensure that all the test stands at all laboratories are running correctly and are operating at the appropriate levels of severity.

Today's major concerns for automotive gear and axle lubrication include improved surface protection and reduced fatigue, high thermal durability, thermal and oxidative stability and seal compatibility. These features lead to reduction in maintenance, downtime and warranty claims. Unfortunately, a lubricant conforming simply to API GL-5 may not necessarily meet these criteria. The API GL-5 standard does not require field testing or a test for oil seal compatibility, and does not address the need for thermal stability, which can lead to damage of oil seals through deposit build-up. Further, MIL-L-2105D specification was upgraded to MIL-PRF-2105E, which was later re-written as SAE J2360. The industry has moved from MIL-L-2105D to SAE J2360, which exceeds API Service Classification API GL-5 and is intended for the lubrication of hypoid-type, automotive gear units, operating under conditions of high-speed/shock load and low-speed/high-torque. This approval also requires acceptable performance in controlled field tests in both light- and heavy-duty equipment. These lubricants may be appropriate for other gear applications also where the position of the shafts relative to each other and the type of gear flank contact involve a large percentage of sliding contact. Such applications typically require extreme pressure (EP) additives to prevent the adhesion and subsequent tearing away of material from the loaded gear flanks. However, these lubricants are not appropriate for the lubrication of worm gears.

The approval for SAE J2360 qualification shall require acceptable performance in controlled field tests in both light- and heavy-duty equipment. Demonstration of compliance with the requirements of standard and listing on the Qualified Products List (QPL) administered by the Lubricant Review Institute (LRI) is part of product approval process.

SAE J2360 (May 2022) may be referred for detailed physicochemical, performance, and technical requirements for approval and for approval procedure. A complete listing of qualification requirements and procedures can be found in the Program Document (PD4000), Gear Lubricant Review Program, available on the Performance Review Institute (PRI) website, www.p-r-i.org.

This third revision has been brought out to keep pace with the latest technological developments and international practices. In this revision, the following changes have been made:

a) Qualification Approval for defence products (only) has been included in Annex E; and
b) Requirements from SAE J2360 (May 2022) have been incorporated as a third category, i.e., EP type GL-5 with additional requirements of SAE J2360.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

1.1 This standard prescribes the requirements and methods of sampling and test for multipurpose automotive gear and axle lubricating oils [extreme pressure (EP) type].

1.2 These lubricants are primarily intended for use in automotive hypoid gear units, manual transmission units, final drives, steering gears, and fluid lubricated universal joints of automotive equipment.

WARNING — This standard does not purport to address all the safety problems associated with the use of the lubricant. It is the responsibility of the users of this standard to take appropriate measures to ensure the safety and health of personnel prior to the application of the standard, and to determine the applicability of any other restrictions for this purpose.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards.

3 CLASSIFICATION

3.1 Types

The lubricating oils shall confirm to any one of the 14 mono viscosity grades (*see* Table 1) as distinguished by the viscosity limits prescribed below:

i) EP type GL-4
ii) EP type GL-5
iii) EP type GL-5 with additional requirements of SAE J2360

3.2 Viscosity Grade

The SAE J306 specification is a definition applied to finished lubricants and reflects only the viscosity grade of the fluid. The details of the viscosity classifications are provided below:

Table 1 Viscosity Classification [1]
(*Clause* 3.1 ~~3.2~~)

Sl. No.	SAE Viscosity Grade	Maximum Temperature for Absolute Viscosity of 150 000 cP, °C[2]	Kinematic Viscosity at 100 °C, (mm^2/s)[3]	
			Minimum[4]	Maximum
(1)	(2)	(3)	(4)	(5)
i)	70W	-55	3.8	--
ii)	75W	-40	3.8	--
iii)	80W	-26	8.5	--
iv)	85W	-12	11	--
v)	65	--	3.8	<5.0
vi)	70	--	5.0	<6.5
vii)	75	--	6.5	<8.5
viii)	80	--	8.5	<11.0
ix)	85	--	11	<13.5
x)	90	--	13.5	<18.5
xi)	110	--	18.5	<24.0
xii)	140	--	24	<32.5
xiii)	190	--	32.5	<41.0
xiv)	250	--	41	--

NOTES:
1 cP= 1 mPa.s

[1] Adopted from SAE J306
[2] Using ASTM ASTM D2983
[3] Using IS 1448 (Part 25/Sec1) / ISO 3104 / ASTM D445
[4] Limit must also be met after testing as per CEC L-45-A-99, Method C (20 h)

3.3 The lubricants may also be multi-grade combination of winter and summer grades for example, SAE 75W-90, SAE 80W-90, SAE 85W-140 etc. In such cases, oil shall comply with the winter grade Brookfield requirement and Kinematic Viscosity at 100 °C requirement of summer grade. Furthermore, the finished fluid viscosity after shearing in the 20 h KRL test as per CEC L-45-A-99 must be higher than the lowest permitted for the given grade.

Example: For SAE 75W-90 grade, fluid must have Brookfield Viscosity at -40 °C of < 150 000 cP and Kinematic Viscosity at 100 °C between 13.5 mm^2/s and 18.5 mm^2/s and shall have Kinematic Viscosity at 100° ≥13.5 mm^2/s after KRL Shear.

3.4 Approved Performance Tests

The tests for performance evaluation of oils are summarized below:

3.4.1 Performance Tests for EP type GL-5:

Type of Oil	Approved Performance Tests
EP Type GL-5	**ASTM D7452** Standard Test Method for Evaluation of the Load Carrying Properties of Lubricants Used for Final Drive Axles,

	Under Conditions of High Speed and Shock Loading
	ASTM D6121 (L-37) Standard Test Method for Evaluation of Load-Carrying Capacity of Lubricants Under Conditions of Low Speed and High Torque Used for Final Hypoid Drive Axles
	ASTM D7038 (L-33-1) Standard Test Method for Evaluation of Moisture Corrosion Resistance of Automotive Gear Lubricants
	ASTM D5704 (L-60-1) Standard Test Method for Evaluation of the Thermal and Oxidative Stability of Lubricating Oils Used for Manual Transmissions and Final Drive Axles
	IS 1448 (Part 67) / ISO 6247 / ASTM D892 Standard Test Method for Foaming Characteristics of Lubricating Oils
	IS 1448 (Part 15) / ISO 2160 / ASTM D130 Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

3.4.2 Performance Tests for EP type GL-5 with additional requirements of SAE J2360

Type of Oil	**Approved Performance Tests**
EP type GL-5 with additional requirements of SAE J2360	**IS 1448 (Part 67) / ISO 6247 / ASTM D892** Standard Test Method for Foaming Characteristics of Lubricating Oils
	ASTM D7603 Standard Test Method for Determination of Storage Stability and Compatibility in Automotive Gear Oils
	ASTM D7038 (L-33-1) Standard Test Method for Evaluation of Moisture Corrosion Resistance of Automotive Gear Lubricants
	ASTM D5704 (L-60-1) Standard Test Method for Evaluation of the Thermal and Oxidative Stability of Lubricating Oils Used for Manual Transmissions and Final Drive Axles)
	ASTM D7452 (L-42) Standard Test Method for Evaluation of the Load Carrying Properties of Lubricants Used for Final Drive Axles, Under Conditions of High Speed and Shock Loading **OR** **ASTM D6121 (L-37)** Standard Test Method for Evaluation of Load-Carrying Capacity of Lubricants Under Conditions of Low Speed and High Torque Used for Final Hypoid Drive Axles) **OR** **ASTM D8165 (L-37-1)** Standard Test Method for Evaluation of Load-Carrying Capacity of Lubricants Used in Hypoid Final-Drive Axles Operated under Low-Speed and High-Torque Conditions
	IS 1448 (Part 15) / ISO 2160 / ASTM D130 Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
	ASTM D5662 Standard Test Method for Determining Automotive Gear Oil Compatibility with Typical Oil Seal Elastomers

4 REQUIREMENTS

4.1 General

The gear lubricating oils shall be homogeneous and shall be formulated using mineral lubricating oil base stock (virgin or re-refined or combination thereof), or synthetically prepared base stocks, or a combination of the two types of base stocks compounded with such functional additive materials like viscosity index improvers, pour point depressants, oxidation and corrosion inhibitors, extreme pressure agents, antiwear additives, antifoamants, etc., as are necessary to meet the specified requirements of this standard.

4.2 Physico-Chemical Requirements

4.2.1 *Requirements for Finished Oil*

The oil shall be free from suspended matter, grit, water or any other impurities. The EP Type GL-4 and GL-5 oils shall also comply with physico-chemical requirements prescribed in Table 2 and **4.2.2.**

Table 2 Physico-Chemical Requirements of Gear and Axle Lubricants, Multipurpose, EP Types GL-4 and GL-5

(*Clauses* 4.2.1 *and* G -1.5)

Sl No.	Characteristic	Requirements for Viscosity Grade														Methods of Tests
		SAE 70 W	SAE 75 W	SAE 80 W	SAE 85 W	SAE 65	SAE 70	SAE 75	SAE 80	SAE 85	SAE 90	SAE 110	SAE 140	SAE 190	SAE 250	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
i)	Appearance	When examined in transmitted light in a colourless glass test tube of 25 mm diameter, the oil shall be clear, bright and free from turbidity and sediment														Visual
ii)	Kinematic Viscosity, mm^2/s at 100 °C	*3.8, Min*	3.8, *Min*	8.5, *Min*	11.0, *Min*	3.8 to <5.0	5.0 to <6.5	6.5 to <8.5	8.5 to <11.0	11.0 to <13.5	13.5 to <18.5	18.5 to <24.0	24.0 to <32.5	32.5 to <41.0	41.0, *Min*	IS 1448 (Part 25/Sec 1) / ASTM D445
iii)	Temperature for Brookfield viscosity of 150 000 cP, °C, *Max*	-55	-40	-26	-12	-	-	-	-	-	-	-	-	-	-	ASTM D2983
iv)	Viscosity index, *Min*	85	85	85	85	85	85	85	85	85	85	85	85	85	85	IS 1448 (Part 56) / ASTM D2270
v)	Flash point, °C, (Cleveland open cup), *Min*	150	150	165	180	150	150	180	180	180	180	180	190	190	200	IS 1448 (Part 69) / ASTM D92
vi)	Copper strip corrosion, *Max*															IS 1448 (Part 15) / ASTM D130
	a) Max/ EP type GL-4, 121 °C for	……Not more than 2……														

	1 h		
	b) EP type GL-5, 121 °C for 3 h	……Not more than 3……	
vii)	Foaming characteristics / tendency / stability		IS 1448 (Part 67) / ASTM D892
	a) At (24 ± 0.5) °C, *Max*	……20/Nil……	
	b) At (93.5 ± 0.5) °C, *Max*	……50/Nil……	
	c) At (24 ± 0.5) °C, *Max*	……20/Nil……	

4.2.2 *Homogeneity and Miscibility, Compatibility and Storage Stability of Finished Lubricating Oils*

4.2.2.1 *Homogeneity and Miscibility*

The finished blended lubricating oil shall have the additive elements uniformly distributed throughout the oil and shall show no evidence of instability at temperature specified in the homogeneity and miscibility test given in Annex B.

4.2.2.2 *Compatibility*

The lubricating oil shall be compatible with all other oils previously qualified under this standard as demonstrated by the compatibility test given in Annex C. The compatibility is determined by mixtures of the oil sample with six selected reference oils designated by Qualifying Authority.

4.2.2.3 *Storage Stability*

The lubricating oil shall satisfactorily pass the storage stability test as described in Annex D.

NOTE — Homogeneity and miscibility (**4.2.2.1)**, compatibility (**4.2.2.2)** and storage stability (**4.2.2.3)** tests are type tests for defence applications. For other applications, these may be mutually decided by supplier and user.

4.3 Requirements of Base Stock

4.3.1 The minimum viscosity index of the base stock used for formulation of gear oil shall not be less than 85.

4.3.2 Each base stock component used in formulation of the gear oil shall be accompanied by the following property data:

i) Kinematic viscosity at 40 °C and 100 °C, in mm^2/s;
ii) Viscosity index;
iii) Flash point, °C;
iv) Conradson carbon residue, percent by mass;
v) Sulphated ash, percent by mass;
vi) Water content, percent by volume;
vii) Total acid number; mg KOH/g;
viii) Pour point, °C;
ix) Sulphur content, percent by mass; and
x) Colour by IS 1448 (Part 12).

4.4 Performance Test Requirements

4.4.1 *EP Type GL-5 Oils*

Table 3 EP Type GL-5 Performance Tests and Acceptance Criteria

Sl No.	Characteristic	Requirement	
		Minimum	*Maximum*
(i)	Test Method ASTM D7452[1),2)]	-	Equal to or better (lower) than the mean scoring values of the passing reference oil test results used to calibrate the stand
	a) Percent Scoring, Pinion	-	
	b) Drive Side	-	
	c) Coast Side	-	
	d) Percent Scoring, Ring	-	
	e) Drive Side	-	
	f) Coast Side	-	
(ii)	Test Method ASTM D6121 or ASTM D8165 using non-lubricated hardware[2),3)]		
	a) Ridging, ASTM Merit rating	8	-
	b) Rippling, ASTM merit rating	8	-
	c) Wear, ASTM merit rating	5	-
	d) Pitting / Spalling, ASTM merit rating	9.3	-
	e) Scoring, ASTM merit rating	10	-
(iii)	Test Method ASTM D7038[4)]		
	a) Final rust merit rating	9.0	-
(iv)	Test Method ASTM D5704[5)]		
	a) Viscosity Increase, percent	-	100
	b) Pentane Insoluble, weight percent	-	3.0
	c) Toluene Insoluble, weight percent	-	2.0
(v)	Test Method for Foaming tendency ASTM D892/IS 1448 (Part 67)		
	a) Sequence I, ml/ml	-	20/nil
	b) Sequence II, ml/ml	-	50/nil
	c) Sequence III, ml/ml	-	20/nil
(vi)	Test Method ASTM D130[6)] / IS 1448 (Part 15)		
	ASTM rating	-	3

NOTES

1) The Canadian version of the ASTM D7452 test follows the procedure of the ASTM D7452 test with the modification mentioned in Annex B-1, Table A 1.1 of that standard.

2)This test may be conducted under two different sets of operating conditions, commonly referred to as Standard and Canadian. The test condition to be used are dependent upon the viscosity grade of the lubricant under evaluation. Please see table 3 for details as to which version of the test should be used in the evaluation of a specific lubricant.

3)The Canadian version of the ASTM D6121 test follows the procedure of the ASTM D6121 test with the modifications mentioned in Annex B-6.2, Table A-6.1 of that standard

4)Candidate fluids tested previous to the development of the ASTM D7038 test procedure using the L-33 test procedure with a cover plate merit rating of a minimum of 8 and a merit rating for all other areas of a minimum of 10 are considered acceptable results against performance requirements of this specification.

5) Carbon or varnish and sludge ratings are reported in the ASTM D5704 test procedure but are not an acceptance criterion for API Category GL-5.

6)Tested for 3 h at 121 °C.

Table 4 EP Type GL-5 Testing Requirements According to the Viscosity Grade of the Candidate Gear Lubricant

Sl No.	Test Method	SAE 70W & SAE 75W	SAE 70W-XX & SAE 75W-XX[1)]	All Other SAE Viscosity Grades
(1)	(2)	(3)	(4)	(5)
1.	Standard Version of Test Method ASTM D7452	Not Required	Required	Required
2.	Canadian Version of Test Method ASTM D7452	Required	Required	Not Required
3.	Standard Version of Test Method ASTM D6121 or ASTM D8165	Not Required	Required	Required
4.	Canadian Version of Test Method ASTM D6121 or ASTM D8165	Required	Required	Not Required
5.	Test Method ASTM D7038 or L-33	Required	Required	Required
6.	Test Method ASTM D5704	Required	Required	Required
7.	Test Method Foaming tendency ASTM D892 / IS1448 (Part 67)	Required	Required	Required
8.	Test Method ASTM D130 / IS1448 (Part 15)	Required	Required	Required

[1)] XX: May be 65, 70, 75, 80, 85, 90, 110, 140, 190, or 250 as indicated in SAE J306.

Table 5 EP Type GL-5 with Additional Requirements of SAE J2360 Tests and Acceptance Criteria

(*Clause* 7)

Sl No.	Measured Parameter	Methods	Minimum	Maximum
(1)	(2)	(3)	(4)	(5)
A	**Physicochemical Requirements**			
1	Viscosity		As per SAE J306	
2	Shear Stability	CEC-L-45-A-99	As per SAE J306	
3	Flash Point, °C	ASTM D92	SAE 70W-XX*-145 SAE 75W-XX*-150 SAE 80W-XX*-160 SAE 85W-XX*-180	--
4	Pour point depressant, percent by volume			2.0#
5	Elemental limitation chlorine, percent by mass	ASTM D6443		0.025
6	Water, percent by mass	ASTM D6304		0.1
B	**Performance Requirements**			
1	Foam Tendency, Sequence I , ml/ml	ASTM D892	---	20/Nil
	Foam Tendency, Sequence II, ml/ml		---	50/Nil
	Foam Tendency, Sequence III, ml/ml		---	20/Nil
2	Storage Stability	ASTM D7603		
	Solid residue, percent by mass		---	0.25
	Liquid residue, percent by volume		---	0.50
3	Compatibility		---	No visual solid or liquid residue
4	Moisture Corrosion	ASTM D7038 (L-33-1)	9.0	
	Final Rust, merit rating			
5	Thermal and oxidative stability	ASTM D5704 (L-60-1)[a]		
	Viscosity Increase at 100 °C, cSt, percent		---	100
	Pentane Insolubles, percent by mass		---	3.0
	Toluene Insolubles, percent by mass		---	2.0
	Carbon/Varnish rating		7.5	---

	Sludge rating		9.4	---
6	Load Carrying and Extreme Pressure Characteristics		Gear lubricant shall prevent or minimize gear distress and lubricant deposits	
7	Gear Scoring - High speed and shock loading conditions	ASTM D7452[b] (L-42)		
	Percent Scoring, Pinion			Equal to or better (lower) than mean scoring value of the passing reference oil test results used to calibrate the stand
	Drive Side		---	
	Coast Side		---	
	Percent Scoring, Ring			
	Drive Side		---	
	Coast Side		---	
8	Gear Distress – Low speed and high torque conditions	ASTM D6121[c] (L-37)		
	Ridging, merit rating		8	--
	Rippling, merit rating		8	--
	Wear, merit rating	ASTM D8165[c] (L-37-1)	5	--
	Pitting/ Spalling, merit rating		9.3	--
	Scoring, merit rating		10	--
9	Copper strip corrosion, at 121 °C for 3 h	ASTM D130	---	2a
10	Elastomer Compatibility	ASTM D5662		
	Polyaccrylate, 150 °C, 240 h			
	Elongation Change (percent)		-60	No limit
	Hardness Change, pints		-35	5
	Volume Change, percent		-5	30
	Fluroelastomer, 150 °C, 240 h	ASTM D5662		
	Elongation Change (percent)		-75	No limit
	Hardness Change, pints		-5	10
	Volume Change, percent		-5	15
C	**Qualification Requirements**			
1.	Companion Lubricants		@	
2.	Qualification Period		Not more than 5 years from dates of its original qualification	
3.	Requalification		Each product must be re-qualified ^	

4.	Field Testing		[+]	
D	**Additional Requirements for Gear Lubricants Intended for the US military**			
1	Efficiency of Axle Gear Lubricants[d]	FED-STD-791 method 7504.0 test limits		0.70 min
	75W-90 Difference of 10 Step Average of Mean Efficiency (Candidate – Baseline), percent			
	75W-140 Difference of 10 Step Average of Mean Efficiency (Candidate – Baseline), percent			0.90 min
2	Compatibility with Limited Slip Differential Clutches[e]	FED-STD-791 method 7506.0 test limits		
	Chatter			0.83 max
	Average Ramp Down Dynamic Coefficient ofFriction for any Cycle			0.10 min

***** XX signifies the high temperature viscosity grade of the lubricant and may be left blank or equal to 80, 85, 90, 110,140, 190, or 250, as indicated in SAE J306

[#] The gear lubricant shall contain no more than 2.0 percent (by volume) of any type of pour point depressant or combination in the final formulation

[a] For SAE 75W-90 and 75W-140 grades the satisfactory performance shall be demonstrated when the oil is tested in accordance with an extended version of ASTM D5704 (L-60-1) for 150 h (instead of 50 h)

[b] ASTM D7452 - oil must be tested in duplicate

[c] ASTM D6121/D8165 - for both untreated and phosphate-treated gears.

[d] The SAE 75W-90 and 75W-140 grades gear lubricant shall provide a measurable improvement in efficiency compared to reference 80W-90 and 85W-140, respectively

[e] For SAE 75W-90 and 75W-140 grades gear lubricant shall be compatible with the wet clutch limited slip differential used in the Stryker vehicle

[@] L-42 and L-37 or L-31-1 are not required for the SAE 85W-140 grades that the lubricant is formulated from base stocks and additives used in a qualified SAE 80W-90

[^] If a product is submitted for requalification, and there has been no change in the standard requirements, the LRI Gear Lubricant Review Committee may, at its discretion, waive complete retesting or require only partial retesting of the product to determine its continued acceptability. Whenever there is a change in the base stock, refining treatment, or additives used in the formulation, requalification shall be required. When the proposed changes are minor and may not be expected to significantly affect performance, the LRI Gear Lubricant Review Committee may, at its discretion, waive complete requalification or may require only partial requalification in order to determine the significance and acceptability of the proposed changes

[+] Qualification tests consist of tests for all of the requirements specified in Section A and B of above table requirements. These tests have been correlated with field performance. New lubricant technology must have demonstrated correlation with field performance for these tests to apply. The Lubricant Review Institute Program Document (PD4000) outlines the requirements for field testing. Copies of these procedures may be obtained by contacting the secretary of the LRI at the Performance Review Institute (*see* Section 1). Once correlation has been demonstrated, only the tests specified herein will be required for further requalification.

5 PRODUCT IDENTIFICATION

To ensure acceptance of only qualified products and for the purpose of product identification, test may be carried out by the purchaser or their agency on the characteristics of the oil and the test results shall be compared with the corresponding figures given in the product identification report. Permissible tolerances of test results are indicated against each of the characteristics (*see* Table 6).

Table 6 Permissible Tolerances for Qualification

(*Clause* 5, 9.2)

Sl No.	Characteristic	Tolerance	Methods of Test
(1)	(2)	(3)	(4)
1.	Relative density	To be reported	IS 1448 (Part 16) / ASTM D4052
2.	Flash point, ºC (COC)	*Minimum* as specified	IS 1448 (Part 69) / ASTM D92
3.	Temperature for Brookfield viscosity of 150 000 cp, ºC	-do-	ASTM D2983
4.	Kinematic viscosity, mm^2/s at 100 ºC	Within the range specified	IS (Part 25/Sec1) / ASTM D445
5.	Viscosity index	*Minimum* as specified	IS 1448 (Part 56) / ASTM D2270
6.	Sulphur, percent by mass	± 20 percent	IS 1448 (Part 33) / ASTM D2622 (XRF)
7.	Phosphorus, percent by mass	-do-	IS 1448 (Part 54) / ASTM D5185 (ICP)
8.	Chlorine, percent by mass	-do-	IS 1448 (Part 50) / ASTM D6443 (XRF WD)
9.	Zinc, percent by mass	-do-	IS 1448 (Part 120) / ASTM D5185 (ICP)
10.	If any other elements present in additives	-do-	ASTM D5185 / ASTM D4629 / ASTM D5762

6 PRODUCT QUALITIFICATION (FOR DEFENCE REQUIRMENTS ONLY)

The lubricating oil shall be qualified for use in defence forces in accordance with the provision of this standard and as per the details provided in **Annex E**. The authority for recommending a Qualification Approval is CQA(PP), Kanpur.

7 PRODUCT QUALITIFICATION (FOR EP TYPE GL-5 WITH ADDITIONAL REQUIREMENTS OF SAE J2360)

The lubricating oil shall be qualified for commercial and military use in accordance with the provision of this standard and as per the details provided in **Table 5, Annex F,** and **Annex G**. This may be applicable as agreed between buyer and seller.

8 PACKING AND MARKING

8.1 Packing

The material shall be packed in metal containers or in any other suitable container as agreed to between the purchaser and the supplier.

8.2 Marking

8.2.1 The containers shall be securely closed and marked with the following information:

a) Indication of the source of manufacture, recognized trade-mark, if any;
b) Name and type of the material;
c) Net mass / volume of the material; and
d) Identification in code or batch number or otherwise to enable the lot of consignment or manufacture to be traced back from records.

8.2.2 All marking including batch number of lot of manufacture shall be made on one flat end when the material is packed in barrels.

8.2.3 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations made there under. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

9 SAMPLING

9.1 Representative samples of the material shall be drawn as prescribed in IS 1447 (Part 1).

9.2 Number of Tests

Tests for all the characteristics given in Tables 1 and 6 of the specification shall be conducted on composite samples.

9.3 Criteria for Conformity

The lot shall be declared as conforming to this specification, if all the test results on the composite sample satisfy the requirements of this specification.

ANNEX A
(*Clause* 2)
LIST OF REFERRED STANDARDS

IS No./ Other standards	*Title*
IS 1447 (Part 1) : 2021	Methods of sampling of petroleum and its products :Part 1 Manual sampling (*second revision*)
IS 1448	Methods of tests for petroleum and its products
(Part 12): 2013/ ISO 2049 : 1996	Determination of colour (ASTM scale) (*second revision*)
(Part 15): 2004/ ISO 2160: 1998	Petroleum products — Corrosiveness to copper — Copper strip test (*third revision*)
(Part 16): 2014/ ISO 3675 : 1998	Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method (*fourth revision*)
(Part 25/Sec 1) : 2018 / ISO 3104: 1994	Transparent and opaque liquids Section 1 Determination of kinematic viscosity and calculation of dynamic viscosity (*second revision*)
(Part 33) : 2021	Sulphur by high pressure decomposition device method (*third revision*)
(Part 50): 2021	Chlorine in new and used lubricants (Sodium Alcoholate Method) (*third revision*)
(Part 54): 2017	Determination of Phosphorus Content — Quinoline Phosphomolybdate Method (*third revision*)
(Part 56): 2013/ ISO 2909: 2002	Calculation of Viscosity Index from Kinematic Viscosity (*third revision*)
(Part 67) : 2020	Determination of foaming characteristics of lubricating oils (*second revision*)
(Part 69): 2019 / ISO 2592: 2017	Determination of flash and fire points — Cleveland open cup method (*second revision*)
(Part 120): 2021	Zinc in lubricating oil (*first revision*)
ISO 6247: 1998	Petroleum products — Determination of foaming characteristics of lubricating oils
ASTM D92-24	Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D130-19	Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
ASTM D445-24	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D892-23	Standard Test Method for Foaming Characteristics of Lubricating Oils

ASTM D2270-24	Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 °C and 100 °C
ASTM D2622-24	Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
ASTM D2983-23	Standard Test Method for Low-Temperature Viscosity of Automatic Transmission Fluids, Hydraulic Fluids, and Lubricants using a Rotational Viscometer
ASTM D4052-22	Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
ASTM D4629-24	Standard Test Method for Trace Nitrogen in Liquid Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection
ASTM D5185-18	Standard Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
ASTM D5662-23	Standard Test Method for Determining Automotive Gear Oil Compatibility with Typical Oil Seal Elastomers
ASTM D5704-24	Standard Test Method for Evaluation of the Thermal and Oxidative Stability of Lubricating Oils Used for Manual Transmissions and Final Drive Axles
ASTM D 5762-24	Standard Test Method for Nitrogen in Liquid Hydrocarbons, Petroleum and Petroleum Products by Boat-Inlet Chemiluminescence
ASTM D6121 -19ae1	Standard Test Method for Evaluation of Load-Carrying Capacity of Lubricants Under Conditions of Low Speed and High Torque Used for Final Hypoid Drive Axles
ASTM D6304-20	Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
ASTM D 6443-24	Standard Test Method for Determination of Calcium, Chlorine, Copper, Magnesium, Phosphorus, Sulfur, and Zinc in Unused Lubricating Oils and Additives by Wavelength Dispersive X-ray Fluorescence Spectrometry (Mathematical Correction Procedure)
ASTM D7038-24	Standard Test Method for Evaluation of Moisture Corrosion Resistance of Automotive Gear Lubricants
ASTM D7450-19	Standard Specification for Performance of Rear Axle Gear Lubricants Intended for API Category GL-5 Service
ASTM D7452-24a	Standard Test Method for Evaluation of the Load Carrying Properties of Lubricants Used for Final Drive Axles, Under Conditions of High Speed and Shock Loading
ASTM D7603-23	Standard Test Method for Determination of Storage Stability and Compatibility in Automotive Gear Oils

ASTM D8165-24	Standard Test Method for Evaluation of Load-Carrying Capacity of Lubricants Used in Hypoid Final-Drive Axles Operated under Low-Speed and High-Torque Conditions
CEC L-45-A-99	KRL Tapered Roller Bearing Shear Stability Test
SAE J306: 2019	Automotive Gear Lubricants Viscosity Classification
SAE J2360: 2022	Automotive Gear Lubricants for Commercial and Military Use
FED-STD-791 Rev. D	Testing method of lubricants, liquid fuels, and related products
(PD4000) : 2022	Gear Lubricant Review Program

ANNEX B
(*Clause* 4.2.2.1)
HOMOGENEITY AND MISCIBILITY TEST

B-1 GENERAL

This test determines whether an oil is and will remain homogenous and whether it is miscible and stable when blended with certain standard oils after being submitted to a prescribed cycle of temperature changes.

B-2 SAMPLE

B-2.1 Test Sample — Approximately 300 ml.

B-2.2 Standard Reference Oils — As approved by the qualifying authority.

B-3 APPARATUS

B-3.1 Test Jar

Clear glass, cylindrical form, flat bottom, approximately 30 mm to 35 mm in inside diameter and 115 mm to 125 mm in height.

B-3.2 Thermometer

-38 ºC to +50 ºC range with 1.0 ºC graduations, 230 mm long and 108 mm immersion.

NOTE — ASTM 5C or equivalent may be used.

B-3.3 Cork

To fit the test jar, bored centrally to take the test thermometer.

B-3.4 Jacket

Glass or metal, water-tight, of cylindrical form, flat bottom, about 115 mm in depth, with inside diameter 9.5 mm to 12.5 mm greater than the outside diameter of the jar.

B-3.5 Disk

Cork or felt, 6 mm in thickness, of the same diameter as the inside diameter of the jacket.

B-3.6 Gasket

A ring gasket, about 5 mm in thickness, to fit snugly around the outside of the test jar and loosely inside the jacket. The purpose of the ring gasket is to prevent the test jar from touching the jacket.

B-3.7 Bath

A cooling bath of a type suitable for obtaining the required temperature.

B-4 PROCEDURE

B-4.1 Shake the oil sample well and pour into six sample jars to the 37.5 mm mark and one sample jar to the 75 mm. Add a reference oil to each of the sample jars to the 75 mm mark. Mix the oils thoroughly and heat to 46 ºC in water bath. After the oils reach room temperature, observe and record the colour and evidence of separation. Determine and record the pour point of oil in each sample jar.

B-4.2 Maintain the temperature of the cooling bath at -1 ºC to +2 ºC. Support the jacket, containing the test jar, firmly in a vertical position in the cooling bath so that not more than 25 mm of the jacket projects out of the cooling medium.

B-4.3 Beginning at a temperature 12 ºC above the expected pour, at each test thermometer reading that is a multiple of 3 ºC, remove the test jar from the jacket carefully and tilt it just enough to ascertain whether there is a movement of the oil in the test jar. The completed operation of removal and replacement shall require not more than 3 s. If the oil has not ceased to flow when its temperature has reached 10 ºC, place the test jar in the jacket in a second bath maintained at a temperature of -18 ºC to -15 ºC. If the oil has not ceased to flow when its temperature has reached -7 ºC, place the test jar in the jacket in a third bath maintained at a temperature of -34.5 ºC. For determinations of very low pour point, additional baths should be maintained with successively lower temperature differentials of about 17 ºC. In each case, transfer the test jar when the temperature of the oil reaches a point of 28 ºC above the temperature of the new bath. At no time, the cold test jar shall be placed directly in the cooling medium. To test the flow, keep the test jar in a horizontal position for exactly 5 s, as noted by a stopwatch or other accurate timing device, and observe carefully. If the oil shows any movement under these conditions, place the test jar immediately in the jacket and repeat a test for flow at the next temperature 3 ºC lower.

B-4.4 Continue the test in this manner until a point is reached at which the oil in the test jar shows no movement when the test jar is held in a horizontal position for exactly 5 s. Certain lubricating oils tend to move as a whole and should be very closely observed. Record the reading of the test thermometer at this temperature, corrected for error, if necessary. Allow the samples to thaw; and when the cloudiness has just disappeared, observe and record the colour and evidence of separation. When the samples reach room temperature, place them in an oil-bath after removing the thermometers. Heat the bath at 230 ºC and immediately remove the sample jars. Cork the samples and store them at their respective pour points for 18 h to 24 h. Remove the jars and allow the sample to thaw.

When cloudiness has just disappeared, observe and record the colour and evidence of separation. Repeat the last operation again when the samples reach room temperature.

B-5 REPORTING

B-5.1 Report evidence of separation for the following four successive stages:

a) Initial sample;
b) Warmed to just above cloud after having once reached pour point;
c) After a cycle of heating to 230 ºC cooling to pour point, storing it for 24 h at this temperature and warming to just above pour point; and

d) Warmed to room temperature.

B-5.2 Evidence of separation is to be reported as:

a) *Condition*

i) Definite
ii) None or doubtful

b) *Location*

i) Near top
ii) Near bottom
iii) Filament
iv) Uniformly distributed

c) *Particle Size*

i) Small, as in cloud or haze
ii) Specks or larger particles

d) *Colour*

i) White or very light colour
ii) Yellow
iii) Black

ANNEX C
(*Clause* 4.2.2.2 *and* F-3)
COMPATIBILITY TEST

C-1 GENERAL

This method is used for determining the compatibility of EP type gear lubricants when blended with a reference gear lubricant by observing for precipitation of additive material after storage.

C-2 APPARATUS

C-2.1 100 ml cone-shaped centrifuge tubes.

C-2.2 Centrifuge with diameter of swing (tip-to-tip of whirling tubes) 375 mm to 425 mm and capable of being controlled at a speed of (1 500 ± 25) rpm.

NOTE — If the available centrifuge does not conform dimensionally to the preferred form, the speed or rotation of the available centrifuge must be adjusted to give the same centrifugal force at the tips of the tubes as that obtained with the prescribed instrument when operated at 1 500 ± 25 rpm. The speed to operate the available centrifuge shall he calculated front the formula:

$$rpm = 1500\sqrt{\frac{16}{d}}$$

where,

d = the diameter of the swing (tip-to-tip of whirling tubes) of the available centrifuge.

C-2.3 Balance capable of weighing to 1 mg.

C-2.4 Constant temperature bath capable of being controlled at (121 ± 1) ºC.

C-2.5 Stirring apparatus capable of stirring the contents of a 400 ml tall form beaker at approximately 200 rpm.

C-2.6 Beaker, 400 ml capacity, tall form, heat resistant glass.

C-2.7 Forced circulation oven capable of being controlled at (104.4 ± 2) ºC.

C-2.8 Desiccator, capable of holding several centrifuge tubes.

C-2.9 Graduated cylinders, 100 ml capacity.

C-3 MATERIALS

C-3.1 Naphtha

C-3.2 Cleaning solution, consisting of concentrated sulphuric acid saturated with potassium dichromate.

C-3.3 Distilled Water

C-3.4 Denatured Ethyl Alcohol

C-3.5 Reference Oils — as approved by the qualifying authority.

C-4 PROCEDURE

C-4.1 Make two compatibility tests with each reference oil.

C-4.2 Determine the residue in each of the reference oils and the sample oil by subjecting each reference oil alone (not mixed with any other oil) to the procedures described in **C-4.7** through **C-4.16**. This data will be used in calculations of compatibility (**C-4.17**).

C-4.3 Preparation of Centrifuge Tubes

Prepare two centrifuge tubes for test with each reference oil.

C-4.4 Support the centrifuge tubes in an inverted position in an oven maintained at (104.4 ± 1) ºC for at least half an hour.

C-4.5 Remove the tubes from the oven, place them in a desiccator, and permit them to cool to room temperature.

C-4.6 Number each tube, weigh to the nearest milligram, and place the tubes in the desiccator until they are to be used.

C-4.7 Thoroughly shake oil sample and reference oils prior to sampling.

C-4.8 Use 110 ml of reference and sample oils.

C-4.9 Heat the beakers containing the reference and sample oils in an oven at (121.1 ± 1) ºC for 20 min. Remove the beakers from the oven and stir (with a mechanical stirrer) the contents while still hot for 5 min.

C-4.10 Transfer 100 ml of the contents of each beaker to weighed centrifuge tubes. Save the remainder of the oil mixture.

C-4.11 Cork the centrifuge tubes and store them in upright position in a dark atmosphere such as a drawer or cupboard at room temperature for a period of 30 ± 1 days.

C-4.12 After the storage period, remove the centrifuge tubes from the storage area, place them in the centrifuge, and operate the centrifuge at (1500 ± 25) rpm for a period of (30 ± 1) min.

> NOTE — During transferring the centrifuge tubes from the storage area to the centrifuge, care must be taken not to disturb any material which may have separated from the oil.

C-4.13 Remove the centrifuge tubes from the centrifuge and decant and discard the supernatant oil. Permit the centrifuge tubes to drain in an inverted position at room temperature for a period of two hours. Discard the draining. If the residue is a solid, wash it with naphtha sufficient number of times to ensure that it is free of oil.

NOTE — If the separated material is not sufficiently compacted by the centrifuge to permit decanting the supernatant oils, continue the centrifuging for 15 min intervals until decanting is possible. If the material is a liquid at the conclusion of 30 min centrifuging period, or if it cannot be compacted, stopper the centrifuge tube and place it in storage for an additional 30 days. At the end of the second storage period, proceed as directed from **C-4.12**.

C-4.14 Place the centrifuge tubes in upright position in an oven controlled at (104.4 ± 1) ºC for approximately 2 h.

C-4.15 Remove the centrifuge tubes from the oven and place them in a desiccator to cool to room temperature. Weigh the tube and contents to the nearest milligram. Subtract the weight of the empty centrifuge tube to determine the weight of the separated material.

NOTE — If the residue remains a liquid at the end of the second 30 days' storage period, centrifuge the tube as specified in **C-4.12**. Remove the tube from the centrifuge and note the volume of the separated liquid to the nearest 0.05 ml.

C-4.16 Pour the remainder of the oil remaining in the 400 ml beaker (approximately 100 ml, *see* **C-4.9**) into a second 400 ml beaker and examine the beaker in which the oils were mixed for sludge or other evidence of incompatibility.

C-4.17 Report

Calculate the percent incompatibility for each reference oil as an average of the values obtained for each reference oil using the following formula:

$$\text{Theoretical zero incompatibility} = R + T$$

$$\text{Evidence of incompatibility} = X - (R + T)$$

$$\text{Percent incompatibility} = \frac{X - (R + T)}{0.9\ (50\ r + 50\ t)} \times 100$$

where

R = weight of separated material in reference oil (g/50 ml of oil), *see* **C-4.2**;
T = weight of separated material in sample oil (g/50 ml of oil), *see* **C-4.2**;
X = weight of separated material found in compatibility test, *see* **C-4.16**;
r = weight percent of additive in reference oil (to be supplied by the supplier of the reference oil);
t = weight percent additive in sample oil (to be supplied by the manufacturer of the sample oil); and
0.9 = assumed specific gravity of both reference oil and sample.

NOTE— It may be of interest to make a chemical analysis of the residue found in the incompatible oil mixture.

ANNEX D
(*Clause* 4.2.2.3)
DETERMINATION OF STORAGE STABILITY

D-1 GENERAL

This method is used for determining the storage stability characteristics of universal gear lubricants.

D-2 APPARATUS

D-2.1 100 ml cone-shaped centrifuge tubes.

D-2.2 Centrifuge with diameter of swing (tip-to-tip whirling tubes) 375 mm to 425 mm and capable of being controlled at a speed of (1500 ± 25) rpm.

NOTE — If the available centrifuge does not conform dimensionally to the preferred form, the speed of rotation of the available centrifuge must be adjusted to give the same centrifugal force at the tips of the tubes as that obtained with the prescribed instrument when operated at 1500 ± 25 rpm. The speed to operate the available centrifuge shall be calculated from the formula:

$$rpm = 1500\sqrt{\frac{16}{d}}$$

where,
d = the diameter of the swing (tip-to-tip whirling tubes) of the available centrifuge.

D-2.3 Balance capable of weighing to 1 mg.

D-2.4 Constant temperature bath capable of being controlled at (121 ± 1) ºC.

D-2.5 Forced circulation oven capable of being controlled at (104.4 ± 1) ºC.

D-2.6 Desiccator, capable of holding several centrifuge tubes.

D-3 MATERIALS

D-3.1 Naphtha

D-3.2 Cleaning solution, consisting of concentrated sulphuric acid saturated with potassium dichromate.

D-3.3 Distilled Water

D-3.4 Denatured Ethyl alcohol

D-4 PROCEDURE

D-4.1 Preparation of Centrifuge Tubes — Prepare three centrifuge tubes.

D-4.2 Support the centrifuge tubes in an upside-down position in an oven maintained at (104.4 ± 1) ºC for at least half an hour.

D-4.3 Remove the tubes from the oven, place them in a desiccator, and permit them to cool to room temperature.

D-4.4 Number each tube and weigh it to the nearest milligram.

D-4.5 Place 320 ml of the sample into a 400 ml beaker and heat in an oven at (121 ± 1) ºC for 20 min.

D-4.6 Remove the beaker from the oven and allow it to cool to (25 ± 3) °C. Place 100 ml of oil from the beaker in each centrifuge tube and cork the tubes. Place the tubes in an upright position, still corked, in a dark area such as a drawer or cupboard at room temperature for a period of 30 ± 1 days.

D-4.7 Remove the tubes from the storage area, place them in a centrifuge at (1500 ± 25) rpm for a period of (30 ± 1) min. If the residue is a solid, wash it with naphtha a sufficient number of times to assure that it is free of oil.

NOTE — During transferring the centrifuge tubes from the storage area to the centrifuge, care must be taken not to disturb any material which may have separated from the oil.

D-4.8 Remove the centrifuge tubes from the centrifuge, decant, and discard the supernatant oil. Permit the centrifuge tubes to drain in an upside down position at room temperature for a period of 2 h .

NOTE — If the separated material is not sufficiently compacted by the centrifuging to permit decanting the supernatant oil, continue the centrifuging for 15 min intervals until decanting is possible. If the material is a liquid at the conclusion of 30 minutes of centrifuging, stopper and place the tube in storage for an additional 30 days. At the end of the second storage period, processed from **D-4.7**.

D-4.9 Place the centrifuge tubes in an upright position in an oven controlled at (104 ± 2.5) ºC for approximately 2 h.

D-4.10 Remove the centrifuge tubes from the oven and place them in a desiccator to cool to room temperature. Weigh the tubes and contents to the nearest milligrams. Subtract the weight of the empty centrifuge tubes to determine the weight of the separated material.

D-4.11 If the residue remains a liquid at the end of the second 30 days' storage period, centrifuge the tubes as specified in **D-4.7**. Remove the tubes from the centrifuge and note the volume of the separate liquids to the nearest 0.05 ml.

D-4.12 Calculation

D-4.12.1 Calculate the average amount of separated residue (solid/liquid) on the basis of three test samples.

D-4.12.2 Calculate the percent insoluble residue in the sample from the formula:

$$\text{Percent Insoluble residue} = \frac{Average\ amount\ of\ separated\ residue,g}{0.9 \times Weight\ percent\ of\ additive\ in\ sample} \times 100$$

where

0.9 = assumed specific gravity of the sample.

NOTE — The weight percent of additive in the sample to be obtained from the manufacturer of the sample.

ANNEX E
(*Foreword* and *Clause* 6)
PROCEDURES FOR QUALIFICATION APPROVAL (FOR DEFENCE REQUIREMENTS ONLY)

E-1 PROCEDURE

E-1.1 The oil shall be qualified for use in defence forces in accordance with the provision of this standard. The authority for recommending a Qualification Approval is CQA(PP), Kanpur.

E-1.2 The CQA(PP), Kanpur, will have following functions:

a) Approval for engine/performance test facilities of laboratories for the purpose of recognizing them to carry out engine/performance test evaluation as required by this standard.

b) Approval for blending and quality control facilities of lubricant manufactures for the purpose of ensuring their ability to manufacture qualified lubricants within the tolerance limits stipulated by this standard.

c) Scrutiny of laboratory test data including evaluation test components for the purpose of assessing whether the candidate lubricant formulation meet the requirements of the standard and accordingly recommend for or against qualifying the products.

E-1.3 Candidate oil companies desirous of obtaining the Qualification Approvals of their products for defence purpose shall apply to the CQA(PP) along with details in prescribed form which requires disclosure of full particulars of the formulation in terms of both base stocks and additive components along with the samples. Such application should be addressed to the designated official of the CQA(PP), Kanpur.

The duly authenticated details required to be provided by the applicant firm to CQA(PP), Kanpur are as follows:

a) Finished product sample of 5 litres in case of liquid lubricants submitted in a single container along with 2 litres of base oil(s) and 50 g to 250 g (or as advised by CQAPP) each of all ingredients / additives being used in the manufacturing of the finished product.
b) Product Identification (PI) data of finished product as per specification (IS 1118). The (PI) data must contain all the below-mentioned test results of the sample, which is submitted for qualification/type approval.
   i. Quality Control / Assurance Test Parameters / Physicochemical test data.
   ii. Qualification / Type Test Parameters.
   iii. Percentage of various elements present due to addition of additives and base oil along with percentage of sulphur present.
c) All the test results of the Quality Control and Assurance Test Parameters and percent of various elements, including sulphur content, should be generated at their own laboratory and the copy of the test report of laboratory, where Qualification/Type test have been carried out, shall be submitted to CQA(PP).

d) Infra-red spectra of the finished product; base oil(s) and all ingredients/additives are also to be submitted along with operating parameters.

e) Formulation details as give under:
   (i) Formulation details of the lubricant;
   (ii) Test reports / technical details / data sheets / specifications of all the materials used in the formulation.
   (iii) Traceability of procurement of base oils and all additives.

f) Certificate regarding compatibility of their products from at least two different propositions with similar type of stores of leading manufacturers such as M/s IOC, M/s BPCL, M/s HPCL, M/s Balmer Lawrie and Co. are to be submitted.

g) Storage stability data of full shelf life carried out at a time interval of six months. Copy of initial and final test report are also to be enclosed with storage stability data.

h) Declaration of minimum shelf life of the product under consideration.

j) In addition to above, firm shall submit engine / performance data or its supplementary supporting data / alternate data to demonstrate that their product meets the required performance level of governing specification.

k) Complete list of laboratory equipment / testing facilities are to be submitted in the following format: -

Sl No.	Name of test equipment & No/s	Test method	Make/ Model & Year of Purchase	Range	Sensitivity / Least Count	Purpose	Calibration status along with calibration certificate

m) CQA(PP), Kanpur reserves the right to demand additional evidence / test regarding the performance of the product and material used.

n) In case of any dispute, the decision of CQA(PP) shall be final.

E-1.5 The CQA(PP) based on an overall review of the test data shall decide whether the candidate oil formulation meets the requirements of this standard.

E-1.6 In the event of CQA(PP) recommending qualification approval, the CQA(PP) shall issue a qualification approval for the product meeting relevant details.

E-1.7 At any time, if there is a change in the base stock or base stock sources refining treatment or additives used in the formulation, requalification will be required. Where the proposed changes are minor, the CQA(PP) may at its discretion recommend waiving complete requalification or may require only partial requalification of the proposed changes.

E-1.8 If a candidate oil company submits a series of viscosity grades for qualification, the performance test will be carried out only on SAE 90 or SAE 80W-90 grades provided the type and dosage of additive in the other grades are identical. The oil company shall file an affidavit

to this effect, and the CQA(PP) will qualify the complete series of oils provided the performance tests are met by the SAE 90 or SAE 80W-90 grade.

E-1.10 In the event the candidate lubricant formulation is found to be marginally failing in some performance tests, the candidate oil company may disclose its formulation particulars to CQA(PP) and request it to consider the possibility of a modified formulation meeting the requirements of this standard. In such event, the CQA(PP) may, in its discretion, suggest limited re-evaluation of the modified formulation. On the basis of such re-evaluation the CQA(PP) may consider recommending qualification approval to the modified formulation.

E-1.11 The oil once approved against the standard will be qualified for a period not exceeding 5 years from the date of the original qualification. When the qualification period has expired the manufacturer shall apply for re-qualification of the product if the manufacturer wishes to maintain the formulation as a current product meeting this standard.

ANNEX F
(*Clause* 7 *and G*-1.1)
SPECIFICATION REQUIREMENTS ADOPTED FROM SAE J2360-2022

F-1 MATERIALS

The gear lubricants covered by this standard shall be derived from petroleum fractions, synthetically prepared compounds, or a combination of the two types of products. They may include re-refined base stocks. The stocks shall be compounded with such functional additives (e.g., extreme pressure agents, corrosion inhibitors, friction modifiers, etc.) as necessary to meet the performance requirements specified in this standard. The base stocks used shall not be considered carcinogenic or potentially carcinogenic as defined under OSHA 29 CFR 1910.1200.

F-2 PHYSICAL AND CHEMICAL PROPERTY REQUIREMENTS

The gear lubricant shall conform to the physical and chemical requirements specified in **5.2.1** through **5.2.6**.

F-2.1 Viscosity

The gear lubricant shall meet the limits for the classification of automotive gear lubricants in rheological terms, as described in SAE J306, for the appropriate viscosity grade (Refer **3.2** viscosity grade table).

F-2.2 Shear Stability

The gear lubricant shall maintain its starting viscosity grade, per SAE J306, when tested in accordance with CEC L-45-A-99 for 20 h.

F-2.3 Flash Point

The gear lubricant shall have a flash point greater than the minimum temperature indicated by Table 7 when tested in accordance with ASTM D92.

Table 7 Flash point requirements
(*Clause* F-2.3)

Sl No.	Property	SAE 70W-XX*	SAE 75W-XX*	SAE 80W-XX*	SAE 85W-XX*
(1)	(2)	(3)	(4)	(5)	(6)
i)	Flash Point, °C, *Min*	145	150	165	180
	* XX signifies the high temperature viscosity grade of the lubricant, and may be left blank or equal to 80, 85, 90, 110,140, 190, or 250, as indicated in SAE J306				

F-2.4 Pour Point Depressants

The gear lubricant shall contain no more than 2.0 percent (by volume) of any type of pour point depressant or combination in the final formulation.

F-2.5 Elemental Limitations

F-2.5.1 *Chlorine*

The gear lubricant chemistry shall limit the amount of chlorine to not more than 0.025 percent by mass (250 ppm) when tested using ASTM D6443.

F-2.6 Contamination

F-2.6.1 *Water*

The gear lubricants shall contain no more than 0.1 percent by mass (1000 ppm) of water using test method ASTM D6304.

F-3 PERFORMANCE REQUIREMENTS

The gear lubricants shall conform to the performance requirements specified in **F-3.1** through **F-3.8.** Annex C summarizes the performance requirements.

F-3.1 Foaming

All grades of gear lubricants shall demonstrate the following foaming characteristics when tested in accordance with ASTM D892. Option A of ASTM D892 is not allowed.

Test Condition	Test Criteria
Initial test at (24 ± 0.5) °C	Not more than 20 ml of foam shall remain immediately following the 5 min blowing period.
Intermediate test at (93.5 ± 0.5) °C	Not more than 50 ml of foam shall remain immediately following the 5 min blowing period.
Final test at (24 ± 0.5) °C	Not more than 20 ml of foam shall remain immediately following the 5 min blowing period.

F-3.2 Storage Stability

The gear lubricants shall demonstrate the following characteristics for separated solid material, liquid material, or a combination of the two materials, when tested in accordance with ASTM D7603.

Solid Material	When the separated material is solid, the average increase in the weight of each centrifuge tube and residue over the initial weight of the clean tube shall not exceed 0.25 percent by mass of the additive material originally contained in the sample.
Liquid	When the separated material is liquid, it shall not exceed 0.50 percent

Material	by volume of the additive material originally contained in the sample

F-3.3 Compatibility

The gear lubricants shall demonstrate compatibility with other gear lubricants previously qualified under this standard when tested against selected reference oils in accordance with ASTM D7603. The candidate lubricant shall show no incompatibility with six reference oils to be obtained from the ASTM Test Monitoring Center (TMC).

F-3.4 Moisture Corrosion

The gear lubricants shall prevent or minimize corrosion to gear unit components in the presence of moisture. Satisfactory performance shall be demonstrated when the oil is tested in accordance with ASTM D7038 (L-33-1 Test) and receives a passing result of 9.0 or better overall rating. It shall not have a rating of 5.0 or less on any individual rating area, and not have more than four areas rated as an 8.0 or less.

F-3.5 Thermal and Oxidative Stability

The gear lubricants shall resist thermal and chemical oxidation. Satisfactory performance shall be demonstrated when the oil is tested in accordance with ASTM D5704 (L-60-1) for 50 h and meets the criteria in Table 8.

Table 8 ASTM D5704 (L-60-1) test limits
(*Clause* F-3.5)

Sl No.	Parameters	Limits
(1)	**(2)**	**(3)**
i)	Kinematic viscosity, percent increase, at 100 °C, cSt, *Max*	100
ii)	*n*-Pentane insolubles, percent by mass, *Max*	3.0
iii)	Toluene insolubles, percent by mass, *Max*	2.0
iv)	Carbon/varnish rating, *Min*	7.5
v)	Sludge rating, *Min*	9.4

F-3.6 Load-Carrying and Extreme-Pressure Characteristics

The gear lubricants shall prevent or minimize gear distress and lubricant deposits under conditions of high-speed and shock-loading and conditions of low-speed, high-torque operation.

F-3.6.1 *Gear Scoring-High-Speed and Shock-Loading Conditions*

Satisfactory performance shall be demonstrated when the oil is tested in duplicate in accordance with ASTM D7452 (L-42) and exhibits scoring equal to or better (lower) than the

mean scoring value of the passing reference oil test results used to calibrate the test stand. For grades SAE 70W, 70W-XX, 75W, and 75W-XX oils, the test shall be conducted per ASTM D7452. In addition, 70W-XX and 75W-XX oils require testing be conducted under standard ASTM D7452 conditions.

F-3.6.2 *Gear Distress-Low-Speed and High-Torque Conditions*

Satisfactory performance shall be demonstrated when the oil is tested in accordance with ASTM D6121 (L-37) or ASTM D8165 (L-37-1) using untreated and phosphate-treated gear assemblies, and prevents gear-tooth ridging, rippling, pitting, welding, spalling, excessive wear, or other surface distress and objectionable deposits. The oil shall not produce excessive wear, pitting, or corrosion of bearing rollers or races. For grades SAE 70W, 70W-XX, 75W, and 75W-XX oils, the test shall be conducted per the Canadian test version. In addition, for 70W-XX and 75W-XX viscosity grade oils, the test shall also be conducted per the standard test version. The oil shall meet the criteria in Table 9.

Table 9 ASTM D6121 (L-37) and ASTM D8165 (L-37-1) Test Limits
(*Clause* F-3.6.2)

Sl No.	Category	ASTM Rating
(1)	**(2)**	**(3)**
i)	Ridging	≥ 8
ii)	Rippling	≥ 8
iii)	Wear	≥ 5
iv)	Spalling/pitting	≥ 9.3
v)	Scoring	10

F-3.7 Copper Corrosion

The gear lubricants shall minimize copper corrosion. Satisfactory performance shall be demonstrated when the oil is tested in accordance with ASTM D130 for 3 h at (121 ± 1) °C, and exhibits copper strip discoloration not exceeding ASTM No. 2a when compared to ASTM Copper Strip Corrosion Standard.

F-3.8 Elastomer Compatibility

The gear lubricants shall minimize deterioration of elastomer materials. Satisfactory performance shall be demonstrated when the oils are tested and rated in accordance with ASTM D5662 (Elastomer Compatibility) and exhibit test results meeting the nominal criteria in Table 10.

Table 10 ASTM D5662 (Elastomer Compatibility) Test Limits
(*Clause* F-3.8)

Sl No.	Parameters	Minimum	Maximum
(1)	**(2)**	**(3)**	**(4)**
i)	Polyacrylate at 150 °C, 240 h		
a)	Elongation change, percent	-60	No limit
b)	Hardness change,	-35	5

	percent		
c)	Volume change, percent	-5	30
ii)	Fluroelastomer at 150 °C, 240 h		
a)	Elongation change, percent	-75	No limit
b)	Hardness change, percent	-5	10
c)	Volume change, percent	-5	15

ANNEX G
(*Clause* 7)

QUALIFICATION REQUIREMENTS — AUTOMOTIVE GEAR LUBRICANTS FOR COMMERCIAL AND MILITARY USE ADOPTED FROM ANNEX A OF SAE J2360-2022

G-1 QUALIFICATION REQUIREMENTS

Below are some key qualification requirements. A complete listing of qualification requirements and procedures can be found in the Program Document (PD4000), Gear Lubricant Review Program, available on the Performance Review Institute (PRI) website, www.p-r-i.org.

G-1.1 Companion Lubricants

Testing prescribed in Clause **F-3.6** of Annex F are not required for the SAE 85W-140 grades, provided that the lubricant is formulated from base stocks and additives used in a qualified SAE 80W-90.

G-1.2 Qualification Period

Each grade of oil which satisfies all the requirements of this standard will be qualified for a period not exceeding 5 years from the date of its original qualification. The qualification period for each grade of SAE 85W-140 oil qualified in accordancewith **G-1.1** shall not exceed that of the companion grade SAE 80W-90 product used in the qualification procedure.

G-1.3 Requalification

When the qualification period has expired, each product must be re-qualified. If a product is submitted for re-qualification, and there has been no change in the standard requirements, the LRI Gear Lubricant Review Committee may, at its discretion, waive complete retesting or require only partial retesting of the product to determine its continued acceptability. Whenever there is a change in the base stock, refining treatment, or additives used in the formulation, requalification shallbe required. When the proposed changes are minor and may not be expected to significantly affect performance, the LRI Gear Lubricant Review Committee may, at its discretion, waive complete requalification or may require only partial requalification in order to determine the significance and acceptability of the proposed changes.

G-1.4 Field Testing

Qualification tests consist of tests for all of the requirements specified in Section 3. These tests have been correlated with field performance. New lubricant technology must have demonstrated correlation with field performance for these tests to apply. The Lubricant Review Institute Program Document (PD4000) outlines the requirements for field testing. Copies of these procedures may be obtained by contacting the secretary of the LRI at the Performance Review Institute (*see* Section 1). Once correlation has been demonstrated, only the tests specified herein will be required for further requalification.

G-1.5 Thermal and Oxidative Stability

A maximum of three tests may be conducted in accordance with ASTM D5704 (L-60-1 Test). If more than one test is conducted, the average of any two test results must meet the limits described in Table 2, and the results from the third test, if conducted, may be excluded.

G-1.6 Additional Requirements for Gear Lubricants Intended for the U.S. Military

For those suppliers intending to sell lubricant products to the U.S. military, only lubricant grades 75W-90, 80W-90, 75W-140, and 85W-140 have been adopted for use. SAE 75W-90 and 75W-140 grade lubricants meeting the additional requirements in this section will be indicated by a unique military identifier on the qualified products list. See the Performance Review Institute's Program Document (PD4000) for further information.

In addition to the requirements outlined in Section E of this standard, SAE grades 75W-90 and 75W-140 shall meet the following additional requirements:

G-1.6.1 *Efficiency of Axle Gear Lubricants*

The 75W-90 and 75W-140 gear lubricant shall provide a measurable improvement in efficiency compared to reference 80W-90 and 85W-140, respectively. Satisfactory performance shall be demonstrated when the oil is tested in accordance with FED-STD-791 method 7504.0

G-1.6.2 *Compatibility with Limited Slip Differential Clutches*

The 75W-90 and 75W-140 gear lubricant shall be compatible with the wet clutch limited slip differential used in the Stryker vehicle (all variants). Compatibility is assessed through the lubricant's ability to mitigate stick-slip during clutch slip events. Satisfactory performance shall be demonstrated when the oil is tested in accordance with FED-STD-791 method 7506.0

G-1.6.3 *Extended Thermal and Oxidative Stability*

The 75W-90 and 75W-140 gear lubricant shall resist thermal and chemical oxidation. Satisfactory performance shall be demonstrated when the oil is tested in accordance with an extended version of ASTM D5704 (L-60-1) for 150 h (insteadof 50 h).

G-1.7 Test Stand Calibration

The latest versions of ASTM test methods D5662, D5704, D6121, D7038, D7452, and D8165 require test stand calibrationby the ASTM Test Monitoring Center. The use of calibrated test stands is required for evaluation of a lubricant against the performance requirements of this standard.

G-2 TOLERANCES

Definite numerical values are not specified for certain of the chemical properties listed in Gear Lubricant Review Program Document (PD4000). Values of some properties vary from one commercial brand of oil to another for the same grade. These values are influenced by the source of the base stock, the identities and quantities of additives, etc. Definite numerical values are not always functionally important except, for some properties, within specified maximum and minimum limits. It is not possible (or necessary) to assign restrictive values in the standard before the testing of qualification samples.

During qualification, test values will be determined which are characteristic of a particular product and which can serve thereafter as guidelines to identify the product. Using the results of qualification testing, the LRI Gear Lubricant Review Committee can set values, including permissible tolerances, for products sold under contract to the U.S. military.