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Technical specification

for the official testing and supply

of greases intended for the lubrication

of railway vehicle roller bearing axleboxes

International Union of Railways

Leaflet to be classified in Volumes:

V - Transport stock
VIII - Technical specifications

Amendments

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Note

This leaflet is part of a set which also includes :

Leaflet 510-1 : Wagons - Running gear - Normalisation.

Leaflet 515 : Coaches - Running gear.

Leaflet 813 : Technical specification for the supply of wheelsets for tractive and trailing stock. Tolerances and assembly.

Leaflet 846 : Technical specification for the supply of roller bearing axle box cases made of spheroidal graphite cast iron.

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0 - General

0.1 - Subject

This specification defines the criteria for selecting greases for railway vehicle roller bearing axleboxes as well as the conditions for the approval, acceptance and use of these greases.

The values quoted relate only to lithium based greases, the use of which is recommended.

Purchasing railways may use greases based on other substances, in which case new values and suitable test methods must be specified. Test methods for greases based on substances other than lithium may to a large extent be derived from the methods described in this specification.

0.2 - Scope

The following provisions are relevant for vehicles used in international traffic.

Depending on the technology, the use of the vehicles and their maintenance regulations the purchasing railways may supplement the obligatory provisions specified for lithium based greases with recommended tests (5.2) to match their requirements or adapt their regulations for other lubricants.

1 - Characteristics of lithium based greases

1.1. - Chemical composition

- Type of soap base : lithium

- Additives : anti-oxidant, anti-corrosive and, if necessary, extreme pressure resistant, etc.

Use of particular greases and additives must not be in contradiction with the laws applicable to the purchasing railway.

1.2 - Application temperature

The lubricating properties of the grease must be guaranteed for temperatures between - 20° C and + 120° C.

1.3 - Conditions

The conditions and the nature and category of the tests (type tests or series tests) for the approval and acceptance of greases are given in paragraph 5.

- Type tests are tests for checking a specific quality level and specifying properties to be met in series tests for the purpose of approval testing,
- Series tests are tests used to check that quality standards are constantly met when an approved grease is supplied.

1.3.1 - Obligatory conditions
Obligatory conditions are given in paragraph 5.1.

1.3.2 - Recommended conditions
Recommended conditions are given in paragraph 5.2.

2 - Approval conditions for greases

2.1 - Manufacture

No special conditions are stipulated for the production of greases, provided the product matches the conditions laid down in paragraph 5 or stipulated by the purchasing railway.

2.2 - Approval of manufacturers

The greases to which this specification applies may only be produced by manufacturers approved by the purchasing railway. The manufacturer must also have installations enabling him to ensure uniform production quality.

2.3 - Approval of greases

2.3.1 - General

The grease samples submitted for approval must be industrially manufactured and not originate in the laboratory. All grease required for approval tests (series tests, type tests and line tests) must be taken from the same production batch and delivered in a single consignment.

The approval applies only to the particular grease submitted to the tests. Any change in the composition of the grease can consequently only be made after prior approval by the purchasing railway.

To obtain such approval the manufacturer is requested to give early notification of any intended change to the purchasing railway to allow sufficient time for carrying out any tests (series tests, type tests or complete approval procedure) required in its view for new approval.

2.3.2 - Approval testing

2.3.2.1 - Type tests

The type tests are shown in paragraph 5.1. If results are satisfactory, the purchasing railway may permit service trials to be held or specify additional tests to be carried out for research purposes (see paragraph 2.3.2.2).

Depending on the intended use of the grease the purchasing railway can choose between 2 tests : DB C1 St V 300, page 15 of this leaflet (Table 1) and the SNCF test ML3 - R2F 1-00, Method 1, page 1, page 17 of this leaflet (Table 1).

2.3.2.2 - Recommended additional tests

These tests are intended to give the purchasing railway additional guarantees, especially for special applications (high speeds, temperature, etc.).
Depending on the intended application the purchasing railway may require one or several of the additional tests given in paragraph 5.2 to be carried out.

2.3.2.3 - Service tests

Service tests shall be made with representative tractive vehicles, coaches and wagons selected by the purchasing railway. If possible, vehicles with a high annual performance and high speed and axle-load for that type of vehicle are selected. The duration of the test depends on the construction type of the test vehicle. Usually it extends over 3 years.
During the test period the purchasing railway assesses the lubricating properties and lubricating abilities of the grease by taking samples and by suitable analysis. The samples must be taken from the rolling area of the axlebox. The amounts of grease taken must be small so as not to endanger the continuation of the service test but large enough to judge whether the test should be continued. Suitable assessment criteria are especially : micro-penetration, drop point, sulphate ash content, iron content, acid number and water content.

A number of test wheelsets must be held in reserve so as to have a sufficient number of roller bearing axleboxes with the grease being tested available throughout the planned test period. In addition, railways are advised to provide a similar number of reference wheelsets with roller bearing grease already approved. The test wheelsets and the reference wheelsets must always be used on the same vehicle. After the end of the service tests, all grease shall be removed from the bearings and the removed grease samples analysed in detail. The roller bearing axleboxes shall be inspected visually.

Approval shall be given when no irregularities ascribable to the grease are found. The purchasing railway shall decide for which type of vehicle, roller bearings, maximum speeds, maximum axle-loads and running distance the grease can be approved.

3 - Acceptance of approved greases

3.1 - Batch formation

Greases produced in the same manufacturing process shall form a batch. Proper homogenisation before drawing off the grease is a pre-condition. The purchasing railway reserves the right to check each batch for homogeneity, at all times.

The minimum batch size shall be specified by the purchasing railway.

3.2 - Test methods

The results of the tests and controls carried out by the manufacturer to ensure the quality of the basic oil must be recorded in writing. The purchasing railway must be allowed to inspect the documentation.

Greases shall be submitted to the obligatory quality control series tests given in Table 1 and, if applicable, to the recommended tests given in Table 2. However, the purchasing railway reserves the right also to check the other properties by random testing.

The series tests are carried out at least once per production batch.

3.3 - Conclusions drawn from the tests

Any test result, or tests, not conforming with the conditions can cause the rejection of the corresponding batch.

4 - Handling of the greases

4.1 - Packing

The greases must be supplied in leakproof packaging.

The packaging unit must be adapted to the site consumption.

4.2 - Labelling

Every package must bear the following :

- Name or brand name of the manufacturer
- Description of the grease
- Net weight
- Manufacturing date and batch number
- Supply number

4.3 - Storage

Greases must be stored under weather protection. If this is impossible, rain protection shall be compulsory.

4.4. - Preservation

After six months storage in the closed original packing, counted from the date of delivery, at temperatures between - 5° C and + 30° C in the conditions specified in paragraph 4.3, greases must have retained the properties described in this specification.

If changes occur before the end of this period, unused greases may be rejected.

5 - Tabular representation of properties

5.1 - Compulsory properties

The compulsory properties, the method of testing (type or series tests) as well as the standard test methods for lithium based lubricants are shown in Table 1.

Non-standard test methods are the subject of Appendix 1.

Depending on application the purchasing railway may choose between DB test C1 St V 300, page 15 of this leaflet (Table 1) and the SNCF test ML3 - R2F 1-00, Method 1, page 17 of this leaflet (Table 1).

Table 1
Quality control test for greases

Properties	Unit	Regulation	Test category		Test method
			Approval (Type)	Quality (Series)	
Colour and appearance		homogeneous	X	X	
Consistency class		2-3	X		NLGI and ISO 2137
Change in work penetration after 60 cycles from approval specimen	0.1 mm	± 15		X	ISO 2137
Change in work penetration after 60000 cycles in relation to work penetration after 60 cycles	0.1 mm	≤60	X		ISO 2137
Drop point	°C	≥180°C	X	X	ISO 2176
Sulphate ash	%	as an indication	X		NF T 60-144 DIN 51 575

Sulphate ash, relative change compared with approval specimen	%	± 20		X	NF T 60-144 DIN 51 575
Acid number	mg KOH/g	≤ 9.0 alk. ≤ 4.5 acid	X	X	DIN 51 809 Part 2
Water content	%	≤ 0.2	X	X	Karl Fischer ISO 3733
Cold behaviour (penetration with non-worked grease at - 20°C)	0.1mm	> 150	X	X	See Appendix 1
Capability of preventing rust formation EMCOR - SKF		0	x	X	NF T 60-135 DIN 51 802 IP 220

Resistance to rolling - impression 1/2 cone deviation before and after test - 4 h at 100°C - penetration deviation	0.1 mm	≤ 60	X	X	ASTM D 1831
Infrared spectrum		as an indication in line with approval specimen	X	X	usual laboratory methods
static oil separation 42 h at 40°C	%	between 0.5 and 6	X	X	IP 121
Water behaviour		1	X		DIN 51 807 Part 1
Oxidation behaviour IROX after 700 h at 130°C	cm^{-1}	≤ 70	X		Apendix 1

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Mechanical and dynamic tests DB trial run 2 with SKF machine			X	X	DB C1 V 300 Appendix 1
- change in mass of roller bearing sets	mg	≤ 50			
- change in mass of bearing cages	mg	≤ 100			
- residual grease in bearing	g	≥ 10			
- assessment criterion	index number				
. wetting power T		1			
. oil carbon ÖK		1			
. consistency change KV		2			
. Sealing A		1			
. oil separation ÖA		2			
. Gel formation C		1			
. participation in rotation UT		1			
. air emulsion E		1			

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- corrosion prevention properties of grease near the rollers EMCOR		0			
- properties of residual grease					
. change in penetration compared with penetration after 60 cycles	0.1 mm	≤60			
. drop point	°C	≥140			
. acid number	mg KOH/g				
. infrared spectrum		no significant change			

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or test with SKF R2F machine SNCF Method 1 (28 days) . appearance of grease . inspection of bearings		. no emulsion . no oil carbon formation . no significant variation in consistency . no heavy oil separation . no dull areas on the bearings . no brown or glossy streaks amounting to wear	X	X	SNCF method ML3-R2F 1-00 Method 1 Appendix 1

- loss of mass of bearings - cages - rollers - housing temperature	 mg mg °C	 ≤ 100 ≤ 25 ≤ 75			

5.2 - Recommended properties

The recommended properties as well as the kind of test (type or series test) and all standard test methods are shown in Table 2.

Non-standard test methods are the subject of Appendix 2.

Table 2

Quality control test for greases

Properties	Unit	Regulation	Test category		Test method
			Approval (Type)	Quality (series)	
Lubricating power Test with SKF R2F machine Method 2 (3 months) - appearance of grease		- no emulsion - no oil carbon formation - no oxidation - no significant variation of consistency - no heavy oil separation	X		SNCF method ML3 - R2F 2-00 Method 2 Appendix 2

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- inspection of bearings		- no dull areas on bearings - no brown or glossy streaks amounting to wear			
- loss of mass of bearing					
- cage	mg	≤ 100			
- rollers	mg	≤ 25			
- housing temperature	°C	≤ 75			
Wear resistance			X		DB C1 St V 301 Appendix 2

DB running test 1 with SKF machine					
- change of mass of roller sets	mg	≤ 50			
- change of mass of cages	mg	≤ 100			
- assessment criteria	index number				
. wetting T		1			
. oil carbon ÖK		1			
. consistency change KV		2			
. Sealing A		1			
. oil separation ÖA		2			
. Gel formation G		1			
. participation in rotation UT		1			
. air emulsion E		1			

- properties of residual grease . change of penetration compared with penetration after 60 cycles	0.1 mm	≤60			
. drop point	°C	≥140			
. acid number	mg KOH/g				
. infrared spectrum		no significant changes			
Endurance test DB running test 2 with the SKF test machine			X		DB C1 St V 302 Appendix 2
- temperature increase above the test temperature of 120°C	°C	≤20			
- change of mass of roller sets	mg	≤50			
- change of mass of cages	mg	≤100			

Friction wear test - specific force Nmax	N	measured	X		DB C 1 ST V 304 Appendix 2
Wear test by friction Reduction of acceptable specific force compared with specimen	N	≤200			
Assessment of particle size of sodium nitrite in the grease - particle size	10^{-3}mm	≤ 5	X	X	DB C1 St V 204 Appendix 2
Mechanical strength and oxidation stability (700 hour test) Grease appearance IROX after 700 hours		no change in consistency ≤ 50	X		SNCF method MEV NM 86 022 ROVITS machine Appendix 2

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Testing of functional characteristics

Properties	Unit	Regulation	Test category		Test method
			Approval (Type)	Quality (Series)	
Miscibility with other approved greases of the same railway			X		DB C1 St V 307 Appendix 2
- mechanical stability of the 1/1 mixture					
. change of penetration after 24 h at ambient temperature	0.1 mm	≤60			
. change of penetration after 24 h at 110°C in relation to worked grease penetration after 60 cycles	0.1 mm	≤150			
. maximum penetration after 24 h at 110°C	0.1 mm	≤400			
. drop point of 1/1 mixture and roller test 24 h at 110°C	°C	≥140			

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Full scale bench tests

Properties	Unit	Regulation	Test category		Test method
			Approval (Type)	Quality (series)	
Fatigue and impact strength - loss of grease	g	≤ 100	X	X	ROPECS Bench (SNCF) MEV NM 86020 Appendix 2
Flow resistance and effectiveness of additives			X		ROPECACS Bench (SNCF) MEV NM 86021 Appendix 2
High pressure - amount of grease forced out	g	≤ 150			
- functional temperature of rollers	°C	≤ 135			
- consumed power	KW	< 2.0			

- apperarance of rollers . steps		no trace of seizing			
. inner rings		-			
. roller ends		-			
. tracks		no discolouring			
Performance					
- temperature of rollers in the load zone with an ambient temperature of 20°C	°C	≤ 65 with a measuring tolerance of 1% ≤ 85	X		MEB bench (SNCF) MEV NM 86019 Appendix 2
- temperature in hot box detection area (OBC zone) with an ambient temperature of 20°C	°C	≤ 55 with a measuring tolerance of 1% ≤ 75			
- temperature deviation measured in the load zone	°C	≤ 15 with a measuring tolerance of 1% ≤ 25			

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- appearance of the rollers		the rollers and the rings must not show any faults such as flaking, seizing, heating. The cages must not show any cracks, incipient cracks, deformation, or abnormal wear			
- increase of Fe content in grease :					
zones 1 and 2	%	≤ 0.5			
zone 3	%	≤ 1			

Compulsory non-standard test methods

French National Railways	Cold temperature behaviour Cold penetration at - 20° C	ML3 PAF 00

1 - TEST PRINCIPLE

Determine the unworked penetration at - 20°C using the penetrometer specified in Standard NF T 60-132.

2 - MATERIAL

- a penetrometer,
- a mechanically-ventilated thermostatic cell, in which testing is carried out at -20°C with an accuracy of ± 1°C.

3 - TEST PROCEDURE

a) Preparation

- fill the oil beaker with grease in accordance with Standard 60-132,
- place in the thermostatic cell, which was previously set to - 20°C, and leave in the cell at the test temperature for 4 h ± 5 min.

b) Measurements

- set up the penetrometer with a measuring cone beside the thermostatic cell
- remove the sample from the thermostatic cell
- take off the grease and measure the penetration immediately.
  Less than 1 minute should pass between removal from the thermostatic cell and measurement.

French National Railways	Dynamic oxidation behaviour of greases Test method	ML3 DYNOX 00

- TEST PRINCIPLE

The grease test samples are aged artificially in order to measure oxidation development over time. The oxidation of a reference grease is tested at the same time.

2 - MATERIAL

A motor connected to a gear wheel arrangement, with which stainless steel pots can be rotated at 100 r.p.m.

Each pot contains a stirring system, which revolves in the opposite direction at 135 r.p.m. (see diagram).

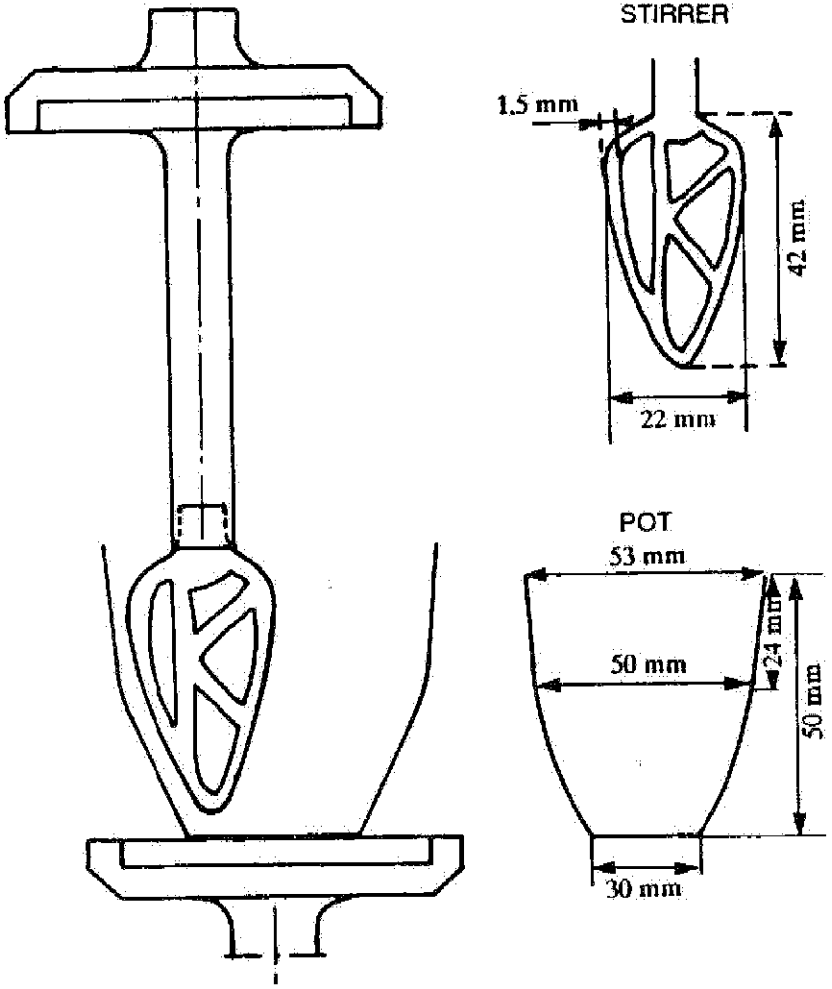
The apparatus must contain at least 4 pots (2 for the test grease and 2 for the reference grease).
- stainless steel pots : see drawing
- stainless steel stirrer : see drawing
- 1 thermostatic cell at 130 ± 0.2°C
- 1 cover, which closes the test apparatus and keeps the temperature evenly distributed. The cover has 2 diametrically opposed holes each with a 5 mm diameter for better air circulation.

3-TEST PROCEDURE

- after cleaning, place 40g grease in each pot. 2 pots are used for each grease sample, regardless whether it is the test grease or the reference grease,
- insert the test apparatus, closed with the cover, into the thermostatic cell at 130 ± 0.2°C,
- start the drive motor,
- every 100 hours remove a sufficiently large grease sample from each pot so as to be able to measure the "IROX" oxidation, as indicated in Appendix 1, page 33.
- take the "IROX" value, which is the arithmetic mean of 2 measurements.

The last sample shall be removed after 700 hours.

Basic scheme of a test apparatus



French National Railways	Dynamic oxidation behaviour of greases IROX oxidation measurement	ML3 IROX 00

1 - DETERMINATION PRINCIPLE

The infrared spectrum of a grease contains an absorption band, which is characteristic of its oxidation. The method consists of the comparison of this band on the grease before ageing and on the grease samples from various stages of ageing.

2 - METHOD

Only a small amount of grease is required. The new grease is distributed between two potassium bromide discs (transparent under radiation), which are separated by an intermediate layer with a thickness D (20 to 200 μm). The infrared spectrum is recorded between 2000 and 1650 cm^{-1}. The same method is applied to artificially aged greases.

3 - RESULTS

From the recordings the infrared oxidation IROX is obtained for each quantity removed, using the formula :

$$IROX = (A + B)\frac{1}{D \text{ in cm}}$$

$$A = \log. \frac{\text{transmission for aged grease at } 2000\ cm^{-1}}{\text{transmission for aged grease at } 1710\ cm^{-1}}$$

$$B = \log. \frac{\text{transmission for new grease at } 1710\ cm^{-1}}{\text{transmission for new grease at } 2000\ cm^{-1}}$$

The individual results enable the IROX curve = f (hours) to be drawn.

No value of the curve must exceed the value stipulated in Table 1.

German Federal Railway Research Institute Munich Chemistry Department	Test with the SKF R2F roller bearing grease test machine DB dynamic test 2	Test Method C1 StV 300

1 - AREA OF APPLICATION

Lubricating greases for roller bearings

2 - PURPOSE

The DB dynamic test 2 serves to obtain proof of the lubricating and running properties of lubricating greases for rail vehicles.

3 - BRIEF DESCRIPTION OF THE METHOD

The grease to be tested is tested in two run-in self-aligning roller bearings under constant radial loading and constant revolutions, but with bearing heating increased in steps over a fixed period of time.

After the test run the test bearings and grease condition are examined.

4.- SAMPLING

The grease to be tested in the self-aligning roller bearings must be taken from a homogeneous sample representative of the batch.

The grease samples to be examined later in the test (e.g. for penetration, drop point, IR test) are taken from the roller zone of the bearing, unless otherwise specified.

5 - APPARATUS AND TEST EQUIPMENT

According to DIN 51 806

6 - PREPARATION OF THE TEST

Before carrying out a test run or running-in a bearing, the alignment and spacing of the test bearing housings must be checked.

Before first use, new test bearings must be checked for their suitability as test bearing in a running-in procedure. The four load zones are marked by the supplier on the outer rings with the numbers 1 to 4. Having passed the running-in procedure, the bearings should be used for no more than four dynamic tests.

The test bearings are taken apart, cleaned with 1,1,1-trichloroethane in an ultrasonic bath, dried for 15 min in the oven at 80°C and the individual parts are weighed after cooling to ambient temperature to an accuracy of one mg. After re-assembly, the bearings are heated for two hours in the heating cabinet to 140°C and immediately mounted on the test shaft. After cooling of the specimens to ambient temperature, radial bearing play is measured by means of feeler gauges. This must be at least 0.050 mm and at most 0.120 mm.

The test bearings are each filled with 50 g ± 1 g of a running-in grease (K 2 K, DIN 51 825) without EP additive and without solid lubricant.

The test bearing housing shall contain no grease filling.

After installation and alignment of the test shaft, running-in of the bearings begins on load zone 1.

Loading : 8340 ± 25 N
r.p.m. : 3 days 1500 ± 125 min^{-1}
: 2 days 2500 ± 125 min^{-1}

Temperature : steady state

The test bearings are lubricated subsequently twice with the machine switched off, but not unloaded :

1st subsequent lubrication after 3 hours with 30 g grease per bearing.
2nd subsequent lubrication after 69 hours with 30 g grease per bearing.

After running-in, the bearings are taken apart, cleaned in the US bath with 1,1,1-trichloroethane, dried, weighted and visually inspected. A test bearing may be used for dynamic tests, when the following conditions were fulfilled during running-in :

Wear of bearing sets < 25 mg
Wear of the two cage halves < 50 mg

7 - INSTALLATION OF BEARINGS AND PREPARING FOR TESTING

The housings are sealed off with 150g test grease.

The test bearings are cleaned, dried, weighed and mounted on the shaft as described in section 6. After filling the bearing with 50 g test grease, the shaft with the mounted bearings is carefully inserted into the machine and aligned, attention being paid to the correct adjustment of the load zone to be tested.

Using a spatula the grease in the test bearing housing is mixed with the grease in the bearing.

After installation and centering of the test shaft, the test begins.

8-DB DYNAMIC TEST 2

8.1 - First test section (steady state running)

The test machine is made to operate under full load. The conditions for this test section are :

Load	: 8340 ± 25N
r.p.m	: 2500 ± 125min^{-1}
Temperature	: Steady state without heating
Duration	: 24 hours ± 30 min
Amount of grease	: 50g ± 1g in bearing 150g ± 1g in housing

The steady state temperature of the two test bearings is measured and recorded. If the steady state temperature of the two test bearings differs by more than 10°C, the test must be terminated.

After completing the test period, the machine is switched off, but not unloaded. After removal of the upper housing, the appearance of the grease is noted. Then 30 ± 0.5g of the grease to be tested is added evenly to each of the two test bearings (approx. 15 g at each bearing side). Finally, the axial alignment of the shaft and, on the test bearings, the location of the load zones is checked and, if necessary, corrected in the unloaded state with the machine still warm. Grease thrown into the cover must be retrieved.

8.2-Second test section (with heating)

After restoration of operational readiness, the machine is put into operation under full load. The following test times and temperatures must be maintained :

1 day with heating at 95 - 100°C
10 days with heating at 105 - 110°C
2 days with heating at 115 - 120°C
2 days with heating at 125 - 130°C

15 days

Load : 8340 ± 25 N
r.p.m. : 2500 ± 125 min^{-1}

After completion of the test period (1 + 15 days), the machine is switched off and unloaded.

9 - EVALUATION

9.1 - Appraisal of the grease

After cooling, the bearing housings are opened to permit the visual appraisal of the condition of the grease in the housing. Then the test bearing shaft with the test bearings is carefully removed and lifted on to the work stand. The outer rings of the test bearings are swung away and the appearance of the grease is noted.

Symbols and coefficients for grease appraisal

	Coefficient		1	2	3
Grease appearance in test bearing	Wetting	T	adequate	moderate	inadequate
	Oil carbon	ÖK	none	moderate	strong
	Consistency change	KV	little	moderate	strong
Grease appearance in test bearing housing	Sealing	A	residual amount of grease > 2/3 of original amount of grease	residual amount of grease > 1/2 of original amount of grease	residual amount of grease > 1/2 of original amount of grease
	Oil separation	ÖA	little	moderate	strong
	Gel formation	G	none	-	yes
	Participation in rotation	UT	none	-	yes
	Air emulsion	E	none	-	yes

Subsequently, as much residual grease as possible is removed from the test bearing and weighed. The following properties of the residual grease from the inside of the bearing are checked :

Penetration : ISO 2137 0.1 mm
Drop point : ISO 2176 °C
Acid number : DIN 51809 mgKOH/g

Infrared spectrogram

The corrosion prevention properties of the grease immediately adjacent to the grease of the housing are tested (approx. 30g - 40 g).

Emcor test DIN 51 802 degree of corrosion

If the residual amount of bearing grease is insufficient, the chemical physical properties are also measured on the grease from the adjacent housing area.

For the exact determination of the amount of residual test grease the uncleaned test bearings are removed from the test shaft and weighed separately to an accuracy of 0.1g. The difference from the mass of the cleaned test bearings (see point 9.2) together with the amount of grease removed earlier represents the residual amount of test grease after the dynamic test.

Residual amount of test grease g.

9.2 - Test bearing examination

After removal of the residual grease, the bearing components are cleaned in the ultrasonic bath with 1,1,1-trichloroethane and dried. The cages and roller sets are then weighed separately to an accuracy of 1mg. The difference between masses before and after the dynamic test represents the respective change of mass.

10 - STATEMENT OF RESULTS

With reference to this regulation the test record must contain:

- description of sample
- change of mass (wear) of roller sets
- change of mass (wear) of cages
- all other observations
- steady state temperature
- overall appreciation

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French National railways	Test with the SKF R2F machine Method 1	ML3 R2F 1-00

1 - PURPOSE

This test serves as proof of the lubricating ability of greases for axle-boxes.

2 - BRIEF DESCRIPTION OF THE METHOD

The grease is tested in two self-aligning roller bearings under constant axial loading and speed, reversing the direction of rotation every 12 hours.

After completion of the test the test bearings and the grease are examined.

3 - TEST MACHINE AND TEST BEARINGS

According to DIN standard 51 806

Note : to prevent premature wear of the roller bearings in the load bearing supports (carrier test bearings) they must be lubricated with an approved grease, to which tricresyl phosphate (2 to 3%) has been added. This product is added to the grease, which is heated to 80°C, and the two are mixed together.

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4 - RUNNING-IN OF THE TEST BEARINGS

Running-in is carried out with the use of TEXACO REGAL STARFAK 2 grease for 48 hours at a speed of 2,500 r.p.m. reversing the direction of rotation every 12 hours.

The grease is introduced into each test bearing in the following quantities :
- 50g before starting,
- 30g after 24 hours running-in.

After running-in, no trace or mark of wear must be apparent, when inspecting the bearings, cages and ring tracks.

5 - TEST PROCEDURE

a) Preparation of the test bearings
- after running-in, the test bearings are removed. With the inner rings wedged on to a shaft, the outer rings, cages and rollers are carefully cleaned with white spirit and then with petroleum ether ;
- after drying, each bearing set and the cages are weighed separately to the nearest mg ;

APPENDIX 1

- bearings are re-installed, the radial play of each bearing is measured and recorded to ensure that it lies between 50 and 120 μm ;
- depending on their condition, the test bearings and carrier bearings can be used up to a maximum of 4 times.

b) Introduction of the grease

Each test bearing is covered evenly with the test grease, which is distributed by manual rotation of the outer rings.
For each test bearing 150 g of grease is then introduced into the lower clean part of the respective bearing.
The shaft is then installed in the machine and the outer rings are then aligned so that the SKF sign is at the top.

c) Test conditions

Radial load	: 8340 ± 25 N
r.p.m.	: 2500
Duration	: 28 days
Reversal of rotation	: every 12 hours

The machine is started without load for 2 hours, after which the load is applied without stopping the machine.

After 24 hours each test bearing shall receive an additional 30 g grease (15 g on each side).

During the test, temperatures are measured frequently at the level of the grease at the lower parts of the test bearings.

6 - TEST BEARING APPRAISAL

The grease is checked in the rollers and in the housings.

The following parameters must be checked with special care :
- Emulsion
- Oil carbon, oxidation
- Consistency
- Oil separation

7 - INSPECTION OF THE TEST BEARINGS AFTER THE TEST

The test bearings are removed from the shaft and taken apart. The components are carefully cleaned as indicated under 5.a.

All dull bearing marks, with or without discolouring, brown or glossy streaks amounting to wear are recorded. The cages and each test roller set are weighed to the nearest mg and the loss of mass incurred during the test is recorded.

Recommended non-standard test methods

German Federal Railway Research Institute Munich Chemistry Department	Test with the SKF R2F bearing grease test machine Wear test, DB dynamic test 1	Test Method C1 StV 301

1 - AREA OF APPLICATION

Lubricating greases for roller bearings

2 - PURPOSE

The DB dynamic test 1 serves to obtain proof of the suitability of greases for high speed running of rail vehicles.

3 - BRIEF DESCRIPTION OF THE METHOD

The grease to be tested is tested in two run-in self-aligning roller bearings under constant radial loading, at increasingly high r.p.m. and constant temperature over a fixed period of time.

After the test, test bearings and grease conditions are examined.

4 - SAMPLING

The grease to be tested in the self-aligning roller bearings must be taken from a homogeneous sample representative of the batch.
The grease samples to be examined later in the test (e.g. for penetration, drop point, IR test) are taken from the roller zone of the bearing, unless otherwise specified.

5 - APPARATUS AND TEST APPARATUS

According to DIN 51 806.

6 - PREPARATION OF THE TEST

Before carrying out a dynamic test or running-in a bearing, the alignment and spacing of the test bearing housings must be checked.
Before first use, new test bearings must be checked for their suitability as test bearing in a running-in procedure. The four load zones of the test bearings are marked by the supplier on the outer rings with the numbers 1 to 4. Having passed the running-in procedure, the bearings should be used for no more than four dynamic tests.

The test bearings are taken apart, cleaned with 1,1,1-trichloroethane in an ultrasonic bath, dried for 15 min in the oven at 80°C and the individual parts are weighed after cooling to ambient temperature to the nearest mg. After re-assembly, the bearings are heated for two hours in the heating cabinet to 140°C and immediately mounted on the test shaft. After cooling of the specimens to ambient temperature, radial bearing play is measured by means of feeler gauges. This must be at least 0.050 mm and at most 0.120 mm.

The test bearings are each filled with 50 g ± 1 g of a running-in-grease (K 2 K, DIN 51 825) without EP additive and without solid lubricant.

The test bearing housing shall contain no grease filling.

After installation and alignment of the test shaft, running-in of the bearings begins on load zone 1.

Loading : 8340 ± 25 N
r.p.m. : 3 days 1500 ± 125 min^{-1}
: 2 days 2500 ± 125 min^{-1}

Temperature : steady state

The test bearings are lubricated subsequently twice with the machine switched off, but not unloaded :

1st subsequent lubrication after 3 hours with 30 g grease per bearing
2nd subsequent lubrication after 69 hours with 30 g grease per bearing

After running-in, the bearings are taken apart, cleaned in the US bath with 1,1,1-trichloroethane, dried, weighed and visually inspected. A test bearing may be used for dynamic tests, when the following conditions were fulfilled during running-in :

Wear of bearing sets < 25 mg
Wear of the two cage halves < 50 mg

7 - INSTALLATION OF BEARINGS AND PREPARING FOR TESTING

The housings are sealed off with 150 g test grease.

The test bearings are cleaned, dried, weighed and mounted on the shaft as described in section 6. After filling the bearing with 50 g test grease, the shaft with the mounted bearings is carefully inserted into the machine and aligned, attention being paid to the correct adjustment of the load zone to be tested.

Using a spatula the grease in the test bearing housing is mixed with the grease in the bearing.

After installation and alignment of the test shaft, the test can begin.

8 - DB DYNAMIC TEST 2

8.1 - First test section (steady state running)

The machine is made to run under full load. The conditions for this test section are :

Load	: 8340 ± 25 N
r.p.m.	: 3500 ± 125 min^{-1}
Temperature	: Steady state without heating
Duration	: 24 hours ± 30 min
Amount of grease	: 50 ± 1 g in bearing
	:150 g ± 1 g in housing

The steady state temperature of the two test bearings is measured and recorded. If the steady state temperature of the two test bearings differs by more than 10°C, the test must be terminated.

After completing the test period, the machine is switched off, but not unloaded. After removal of the upper housing, the appearance of the grease is noted. Then 30 ± 0.5 g of the grease to be tested is added evenly to each of the two test bearings (approx. 15 g at each bearing side). Finally, the axial alignment of the shaft is checked and, if necessary, corrected in the unloaded state with the machine still warm. Grease thrown into the cover must be retrieved.

8.2 - Second test section (with heating)

After restoration of operational readiness, the machine is put into operation under full load. The following test conditions must be maintained :

Load	: 8340 ± 25 N
r.p.m.	: 3500 ± 125 min^{-1}
Temperature	: 80°C
Duration	: 19 days

After completion of the test period (1 day steady state + 19 days with heating), the machine is switched off and unloaded.

9 - EVALUATION

9.1 - Appraisal of the grease

After cooling, the bearing housings are opened to permit the visual appraisal of the condition of the grease in the housing. Then the test bearing shaft with the test bearings is carefully removed and lifted on to the work stand. The outer rings of the test bearings are swung away and the appearance of the grease is noted.

Symbols and coefficients for grease appraisal

	Coefficient		1	2	3
Grease appearance in test bearing	Wetting	T	adequate	moderate	inadequate
	Oil carbon	ÖK	none	moderate	strong
	Consistency change	KV	little	moderate	strong
Grease appearance in test bearing housing	Sealing	A	residual amount of grease > 2/3 of original amount of grease	residual amount of grease > 1/2 of original amount of grease	residual amount of grease > 1/2 of original amount of grease
	Oil separation	ÖA	little	moderate	strong
	Gel formation	G	none	-	yes
	Participation in rotation	UT	none	-	yes
	Air emulsion	E	none	-	yes

Subsequently, as much residual grease as possible is removed from the test bearing and weighed. The following properties of the residual grease from the inside of the bearing are checked :

Penetration	: ISO 2137	0.1 mm
Drop point	: ISO 2176	°C
Acid number	: DIN 51809	mgKOH/g

Infrared spectrogram

The corrosion prevention properties of the grease immediately adjacent to the grease of the housing are tested (approx. 30g - 40 g).

Emcor test DIN 51 802 degree of corrosion

If the residual amount of bearing grease is insufficient, the chemical/physical properties are also measured on the grease from the adjacent housing area.

For the exact determination of the amount of residual test grease the uncleaned test bearings are removed from the test shaft and weighed separately to an accuracy of 0.1g. The difference from the mass of the cleaned test bearings (see point 9.2) together with the amount of grease removed earlier represents the residual amount of test grease after the dynamic test.

Residual amount of test grease g.

9.2 - Test bearing examination

After removal of the residual grease, the bearing components are cleaned in the ultrasonic bath with 1,1,1-trichloroethane and dried. The cages and roller sets are then weighed separately to an accuracy of 1mg. The difference between masses before and after the dynamic test represents the respective change of mass.

10 - STATEMENT OF RESULTS

With reference to this regulation the test record must contain:

- description of sample
- change of mass (wear) of roller sets
- change of mass (wear) of cages
- all other observations
- steady state temperature
- overall appreciation

German Federal Railway Research Institute Munich Chemistry Department	Test with the SKF R2F bearing grease test machine Wear test, DB dynamic test 2	Test method C1 St V 302

1 - AREA OF APPLICATION

Lubricating greases for roller bearings of railway vehicles

2 - PURPOSE

The DB dynamic test II (endurance test) serves to compare running times up to hot box conditions, because the bearing temperature lies above the normal operating temperature.

3. BRIEF DESCRIPTION OF THE METHOD

During the test run, the bearing temperature, and after the test run, the bearing condition is assessed.

4. SAMPLING

The grease to be tested in the self-aligning roller bearings must be taken from a homogeneous sample representative of the batch.

The grease samples to be assessed during the test (e.g. for penetration, drop point, IR test) are taken from the roller zone of the bearing, unless otherwise specified.

5 - APPARATUS AND TEST EQUIPMENT

According to DIN 51 806

6 - PREPARATION OF THE TEST

Before carrying out a dynamic test or running-in a bearing, the alignment and spacing of the test bearing housings must be checked.

Before first use, new test bearings must be checked for their suitability as test bearing in a running-in procedure. The four load zones of the test bearings are marked by the supplier on the outer rings with the numbers 1 to 4. Having passed the running-in procedure, the bearings should be used for no more than four dynamic tests.

The test bearings are taken apart, cleaned with 1,1,1-trichloroethane in an ultrasonic bath, dried for 15 min in the oven at 80°C and the individual parts are weighed after cooling to ambient temperature to the nearest mg. After re-assembly, the bearings are heated for two hours in the heating cabinet to 140°C and immediately mounted on the test shaft. After cooling of the test bearings to ambient temperature, radial bearing play is measured by means of feeler gauges. This must be at least 0.050 mm and at most 0.120 mm.

The test bearings are each filled with 50 g ± 1 g of a running-in grease (K 2 K, DIN 51 825) without EP additive and without solid lubricant.

The test bearing housing shall contain no grease filling.

After installation and alignment of the test shaft, running-in of the bearings begins on load zone 1.

Loading : 8340 ± 25 N
r.p.m. : 3 days 1500 ± 125 min^{-1}
: 2 days 2500 ± 125 min^{-1}

Temperature : steady state

The test bearings are subsequently lubricated twice with the machine switched off, but not unloaded :

1st subsequent lubrication after 3 hours with 30 g grease per bearing,
2nd subsequent lubrication after 69 hours with 30 g grease per bearing.

After running-in, the bearings are taken apart, cleaned in the US bath with 1,1,1-trichloroethane, dried, weighed and visually inspected. A test bearing may be used for dynamic tests, when the following conditions were fulfilled during running-in :

Wear of bearing sets < 25 mg
Wear of the two cage halves < 50 mg.

7 - INSTALLATION OF BEARINGS AND PREPARING FOR TESTING

The housings are sealed off with 150 g test grease.

The test bearings are cleaned, dried, weighed and mounted on the shaft as described in section 6. After filling the bearing with 50 g test grease, the shaft with the mounted bearings is carefully inserted into the machine and aligned, attention being paid to the correct adjustment of the load zone to be tested.

Using a spatula the grease in the test bearing housing is mixed with the grease in the test bearing.

After installation and alignment of the test shaft, the test can begin.

8 - DB DYNAMIC TEST 2

8.1 - First test section (steady state running)

The machine is made to operate under full load. The conditions for this test section are :

Load	: 8340 ± 25 N
r.p.m.	: 500 ± 125 min^{-1}
Temperature	: Steady state without heating
Duration	: 24 hours ± 30 min
Amount of grease	: 50 ± 1 g in bearing
	: 150 ± 1 g in housing

The steady state temperature of the two test bearings is measured and recorded. If the steady state temperature of the two test bearings differs by more than 10°C, the test must be terminated.

After completing the test period, the machine is switched off, but not unloaded. After opening the bearing covers, the appearance of the grease is noted. Then 30 ± 0.5 g of the grease to be tested is added evenly to each of the two test bearings (approx. 15 g at each bearing side). Finally, the axial alignment of the shaft and the location of the load zones is checked and, if necessary, corrected in the unloaded state with the machine still warm. Grease thrown into the cover must be retrieved.

8.2 - Second test section (with heating)

After restoration of operational readiness, the machine is put into operation under full load. The following test conditions must be maintained;

Load:	8340 ± 25 N
R.p.m:	500 ± 125 min^{-1}
Temperature:	120°C
Duration	33 1/3 days

During the test the bearing temperature must be monitored to see whether self-heating of the bearing occurs due to lack of lubrication.

After completion of the test period (1 day steady state + 33 1/3 days with heating), the machine is switched off and unloaded.

9 - EVALUATION

9.1 - Bearing temperature

Temperature increases above 120°C during the running test must be recorded noting the magnitudes and development over time.

9.2 - Test bearing examination

The test bearing shaft with the test bearings is carefully removed and lifted on to the work stand. After removal of the residual grease, the bearing parts are cleaned with 1,1,1-trichloroethane in the ultrasonic bath and dried. The cages and roller sets are then weighed separately to the nearest mg. The difference between masses before and after the dynamic test represents the corresponding change of mass.

10 - STATEMENT OF RESULTS

With reference to this regulation the test record must contain :

- description of sample
- change of mass (wear) of roller sets
- change of mass (wear) of cages
- steady state temperature °C
- maximum bearing temperature °C
- length of time, during which the test temperature was exceeded by 20°C...h
- length of time until the test temperature was exceeded from the beginning of the test...h
- overall appreciation.

German Federal Railway Research Institute Munich Chemistry Department	Fatigue, Friction, Wear Test (FFW test) Ball- Plate System	Test Method C1 StV 304

1 - AREA OF APPLICATION

Lubricants with EP (extreme pressure) action.

2 - PURPOSE

The FFW test serves to obtain proof of the fatigue-friction-wear behaviour under high area pressure. Lubricants of the same type are compared.

3 - BRIEF DESCRIPTION

The lubricant is tested with a friction system consisting of a steel ball and a steel plate. Before the beginning of the test the contact area is lubricated once with the lubricant to be tested. Friction force **R** or friction coefficient μ is measured for an oscillatory, sliding ball movement with a known normal force **N**.

4 - DIMENSIONS, PARAMETERS

4.1 - Standard parameters

If possible, the following parameters should not be varied :

Ball diameter **K**	: 10 mm
Plate diameter **D**	: 24 mm
Plate height **H**	: 8 mm
Frequency **F**	: 50 Hz
Amplitude A	: ± 0.5 mm

4.2 - Variable parameters

Depending on the test procedure and the intended application the following parameters are variable :
- Test temperature ϑ
- Normal force **N**
- Test duration **t**
- Surface pressure **p**

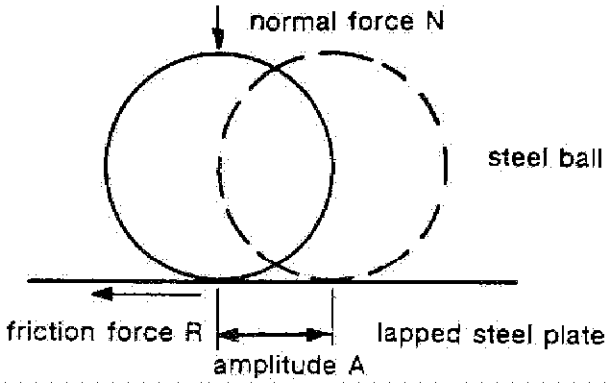
4.3 - Measurements

The FFW apparatus permits detection of the following signals in relation to the parameters listed under 4.1 and 4.2 :
Friction force **R**
Friction coefficient μ
Test duration **t**

5 - TEST APPARATUS

5.1 - Functionning

The tests are carried out with an optimal type FFW apparatus. In the apparatus measurements are made at the contact point between ball and surface (plate), which is wetted with the lubricant to be tested.



The plate rests on a piezo-electric pressure cell, measurements being taken in two dimensions. The ball is pressed on to the lapped plate with a nominal force N and made to slide (not rotate) horizontally on the plate surface with an oscillatory amplitude A.
The test equipment is surrounded by a temperature-controlled case so that constant ambient temperatures can be generated during measurement.

5.2 - Signals measured

With a fixed amplifier setting the pressure cell generates a signal which is proportionate to the friction force **R**. The pen recorder registers only the absolute peak value of this signal.
If the amplification of the piezo-electric force signal **R** is varied in an inverse proportion to the normal force N, the pen recorder trace is proportionate to the friction coefficient μ. We then obtain :

$$\mu = \frac{R}{N}$$

The value is displayed on the pen recorder.
On the other hand, if the amplification of the friction force signal is held constant, the recording varies naturally with the corresponding change of the normal force. The signals of the friction force **R** and the friction coefficient μ are shown on a pen recorder as a function of the test duration t.

6 - PREPARATION

Before use in the FFW apparatus, the test balls and test plates are cleaned in the ultrasonic bath and checked for defects under the microscope (with 20 times magnification).

When testing greases, the amount of grease is measured on to the ball by using a mask so that comparison measurements are always carried out with the same volume of grease. With oil tests oil volumes should be similar.

7 - TEST PERFORMANCE AND RECORDING

At the beginning of each test, ball and plate must be run-in, which is obtained by operating for approx. 10 s at 50 Hz with a normal force N = 50 Newton. For the subsequent test 4 different test arrangements (see appendix 1) are available :

7.1 - Continuous force increase

In this case the normal force N is continuously increased by constant actuation of the load switch. The friction force R is recorded as a function of time t. If lubricant failure marked by a spontaneous increase of the friction force occurs, the normal force N must be recorded.

7.2 - Step-by-step test
The normal force N is increased in stages of 50 N every 3 minutes during the test. Recording as under paragraph 7.1.

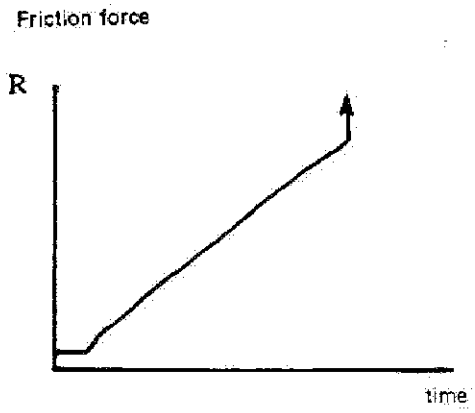
7.3 - Long term test, friction force R
After running-in (with 50 N), the normal force is raised to the test level in one step and retained until something specific occurs, or terminated after 2 hours. The amplifier setting remains constant as in paragraphs 7.1 and 7.2 Recording as under paragraph 7.1.

7.4 - Long term test, friction coefficient μ
After running-in (with 50 N), the normal force is raised to the test level in one step and retained until something specific occurs, or the test is terminated after 2 hours. The amplifier setting is adjusted in relation to the intended friction force so that the friction coefficient μ is always shown on the recording instrument as a function of the test duration.

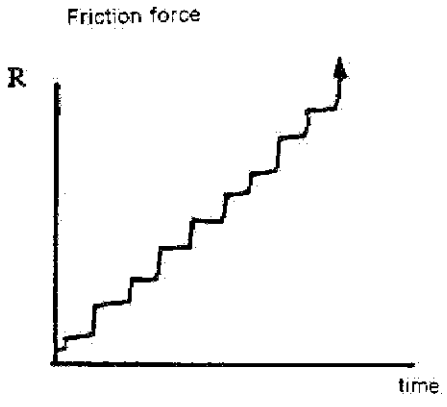
8 - RESULTS AND APPRAISAL

The results of different tests are to be compared. This is only possible, when the test parameters are identical. It must be possible to obtain the values listed under paragraph 4 from the test records. Events recorded in identical conditions must be given, such as friction force peaks or friction coefficients as functions of the normal force N or time.

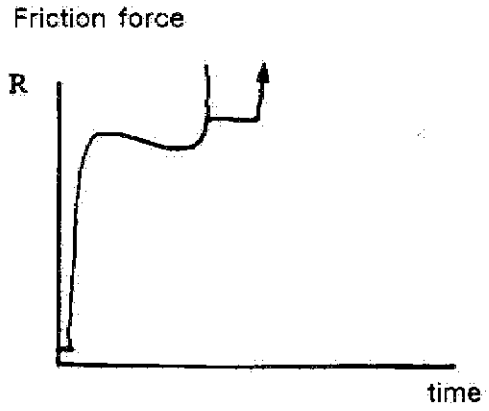
German Federal Railway Research Institute Munich Chemistry Department	4 possible test alternatives for FFW test	Test method, Appendix 1 to C1 St V 304



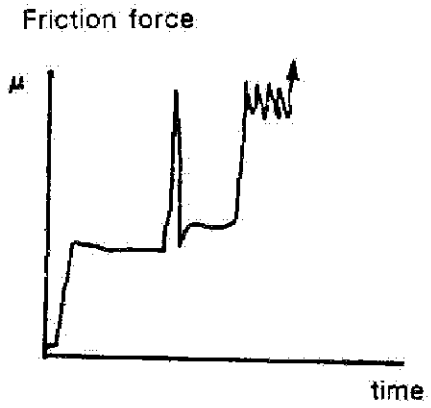
Paragraph 7.1 - Continuous force increase



Paragraph 7.2 - Step-by-step test



Paragraph 7.3 - Long term test, friction force R



Paragraph 7.4 - Long term test, friction coefficient μ

German Federal Railway Research Institute Munich Chemistry Department	Assessment of sodium nitrite particle size in greases	Test method C1 St V 204

1 - AREA OF APPLICATION

Unused greases containing sodium nitrite.

2 - PURPOSE

The method serves to distinguish between

- finely distributed sodium nitrite with a maximum particle size of 5 μm and
- non-uniformly distributed, agglomerated sodium nitrite with a particle size exceeding 5 μm.

3 - CONCEPT

With this test method grain size or particle size is the greatest linear extension of a particle under the microscope.

4 - APPARATUS

- Object glass and cover glass according, for example, to DIN 58 884
- Light transmission microscope, magnification at least 300 times
- Microscope camera (e.g. polaroid camera)
- Line grading (micrometer glass) with 100 lines per mm.

5 - SPECIMEN PREPARATION

With a glass rod a small sample is taken from the grease to be tested, placed on an object glass and covered with a cover glass. After placing a rubber stopper on to the cover glass, the specimen is compressed by hand, applying pressure at the same time as exerting a circular movement. Excess grease is removed.

6 - TEST PERFORMANCE

The specimen is viewed in the light transmission microscope with approx. 300 times magnification ; if necessary, a photograph is taken. As proof the line grading should also be photographed, if required, with the same setting. The grading scale should subsequently be entered on the photographs (see Appendix 1).

7 - EVALUATION

The magnitude and distribution of the sodium nitrite crystals are compared with the examples shown in the photographs on page 73 and judged accordingly.

8 - PRESENTATION OF THE RESULTS

With reference to this test method the magnitude of the results is given as > 5 μm or < 5 μm. If required, the linear extension of the largest three particles found in the pictures is shown to the nearest 5 μm.

9 - NOTE

The particle size and distribution of the sodium nitrite have an effect on the infrared spectrogram of the grease. From the presence or absence of specific absorption bands it is possible to draw conclusions concerning the particle size and distribution.

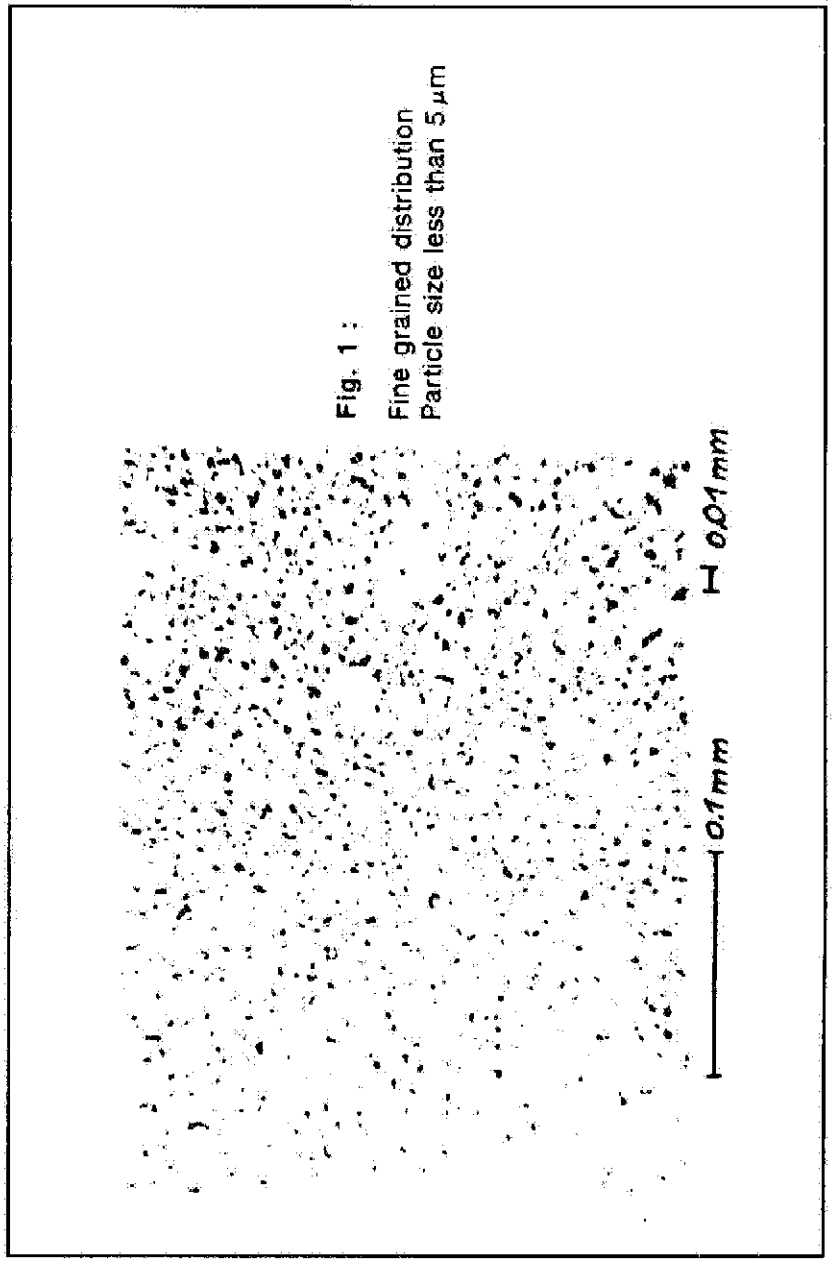


Fig. 1 :
Fine grained distribution
Particle size less than 5 µm

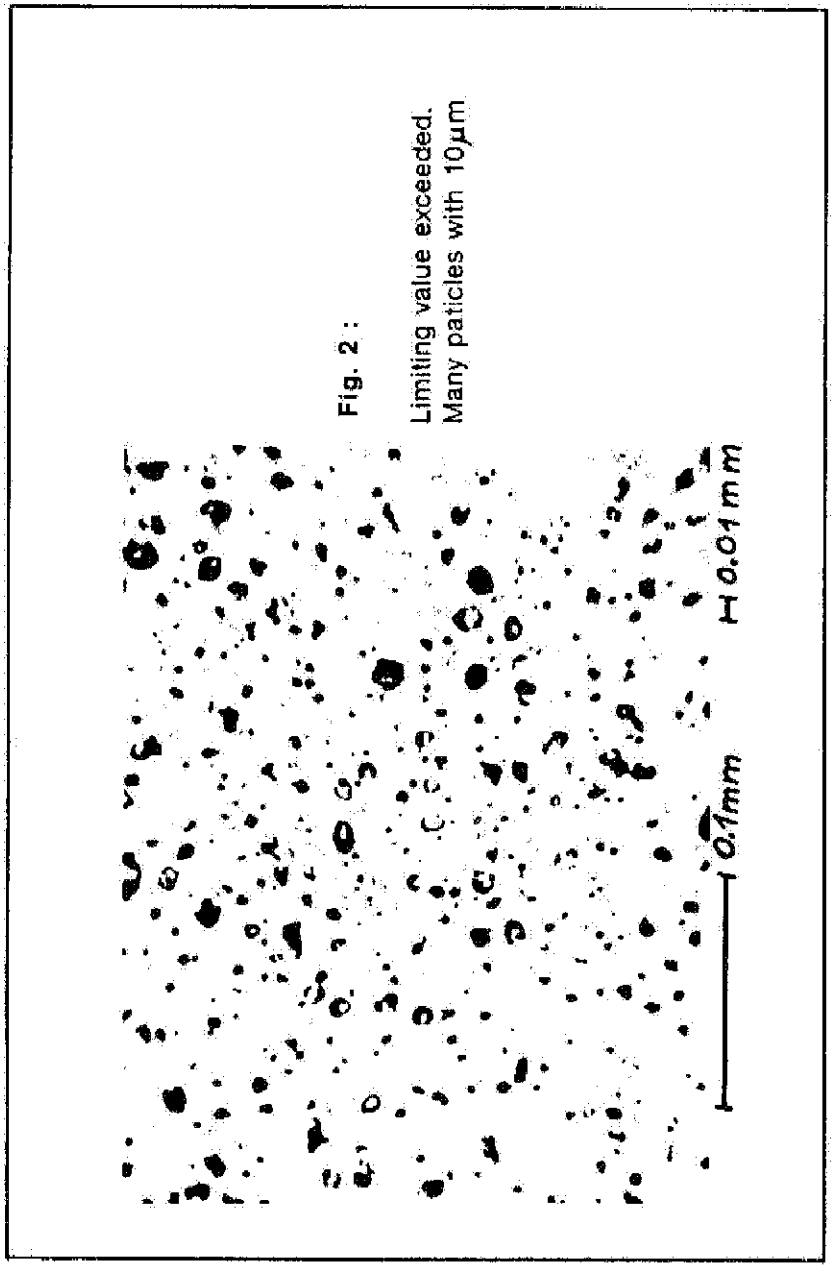


Fig. 2 :
Limiting value exceeded.
Many paticles with 10µm

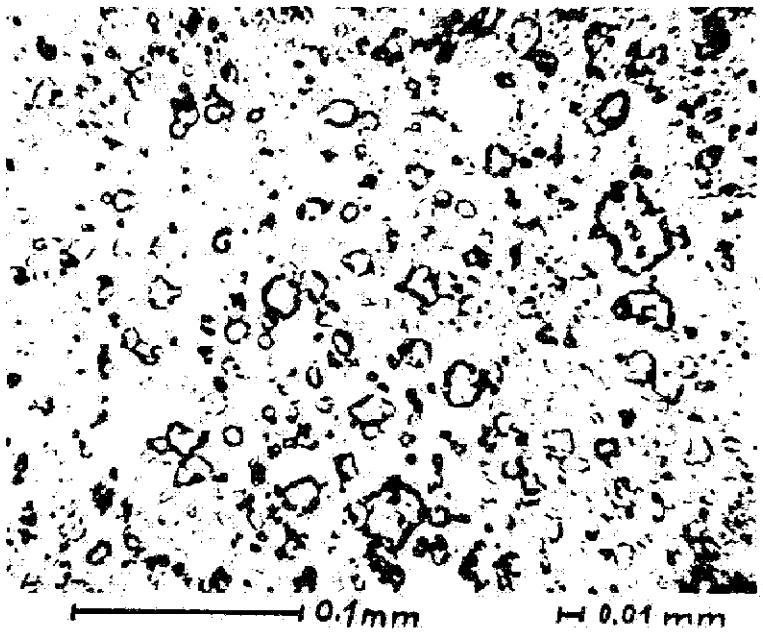


Fig. 3 :

Irregular distribution.
Agglomerates.
Permissible particle size greatly exceeded.

French National Railways Rolling Stock Department Research Institute	Grease testing machine Oxidation of components	MEV NM 86 022

"ROVITS"M
(ROtation, VIbration, TemperatureS)

1 - TEST OBJECTIVE

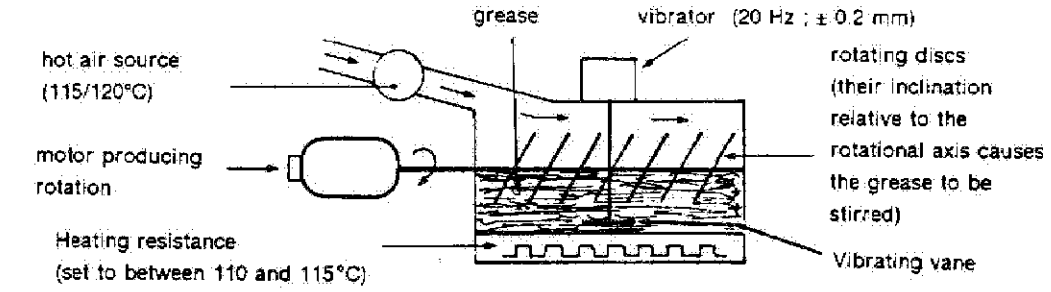
Accelerated ageing of tested greases

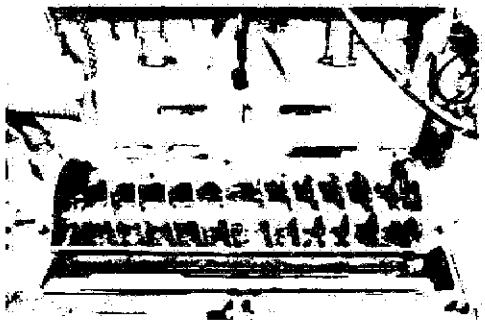
2 - TEST PRINCIPLE

The grease is introduced into an apparatus, which contains discs and rotates slowly (see drawing below and photograph to the left).

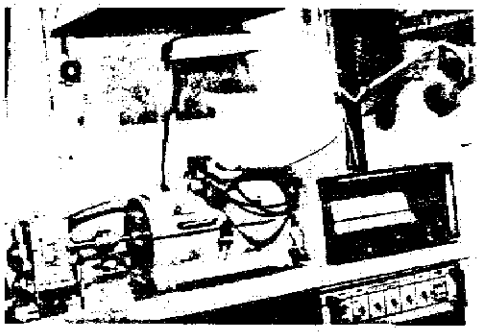
A blower provides a constant hot air supply (115° C/120°C).

A pulsator with a vane imparts vibrations on the grease at 20 Hz and an amplitude of ± 0.20 mm.





Mixing container
(Hood open)

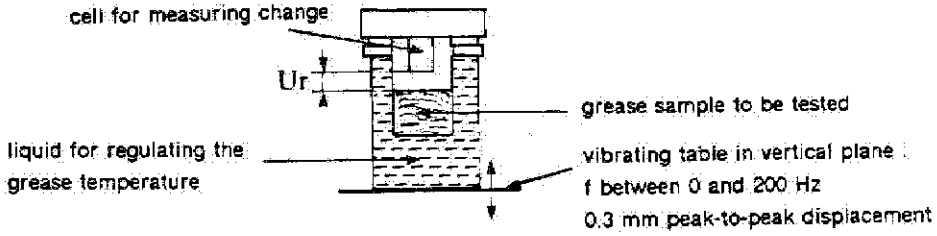


General view of
test equipment

The test lasts for 700 hours. A sample is removed every 100 hours.

The measurements applied to the samples concern in particular :

- oxidation development caused by the new grease : this measurement is conducted by the Laboratory and Inspection Department (ML)
- the flow behaviour of the grease : a cylinder-shaped grease sample is submitted to vibrations with a frequency varying between 0 and 200 Hz and a constant amplitude of 0.3 mm. The relative displacement UR of the grease cylinder (see diagram below) produced by the load is measured. This test is carried out with the new grease and then with the grease having undergone ageing in the ROVITS machine.



With the measurements it is also possible to determine a value E, similar to a "flow behaviour modulus", characterising the viscosity of the grease and its vibration behaviour : the greater the value of E (N/mm^2), the more fluid the grease.

French National Railways	Tests with the SKF R2F machine Method 2	ML 3-R2F-2-00

1 - PURPOSE

Specification of the lubricating ability of greases for axle-box housings after a long term test.

2 - BRIEF DESCRIPTION OF THE METHOD

See Method ML 3 - R2F 1-00

3 - TEST APPARATUS AND ROLLER BEARINGS

See Method ML 3 - R2F 1-00

4 - RUNNING-IN OF THE TEST BEARINGS

See Method ML3 -R2F 1-00

5 - TEST PROCEDURE

- Preparation of the bearings and the greases

See Method ML 3 - R2F 1-00

- Test conditions

Radial loading	: 8340 ± 25 N
r.p.m.	: 3000
Duration	: 3 months
Reversal of rotation	: every 12 hours

6 - CHECKING OF GREASES AND BEARINGS AFTER THE TEST

See Method ML3 - R2F 1-00

814 OR

German Federal Railway Research Institute Munich Chemistry Department	Mechanical consistency and miscibility of roller bearing grease (SHELL bearing test)	C1 St V 307

A - AREA OF APPLICATION

The method consists of a procedure characterising the behaviour of lubricating grease which with the shear stresses acting in ball and roller bearings must lose only a slight degree of its consistency so that it cannot flow out of the bearings. In addition, the test serves as proof of the miscibility of ball and roller bearing greases.

2 - BRIEF DESCRIPTION OF THE TEST

The lubricating grease is subjected to shear stresses at ambient or higher temperature in a rotating cylinder, which contains an iron roller weighted with lead. Before and after the test the consistency of the lubricating grease is determined with a quarter cone, DIN 51804, Part 2.

To test the miscibility of two greases the same test is carried out with a 1:1 grease mixture. Apart from penetration, the drop point of the mixture is also measured after the rolling test.

3 - TEST APPARATUS

- SHELL roller according to ASTM D 1831
- Penetrometer according to DIN 51804, quarter cone
- Drop point measurement according to ISO 2176.

4 - TEST PERFORMANCE

Roller and cylinder are first cleaned with petroleum ether, then with pure alcohol and dried with a clean cloth.

Using a spatula 80 g of the sample is introduced into a cylindrical tube, the roller is inserted and the tube is closed with the screw top. To ensure free rolling the cylindrical tube is rolled on the floor until it continues to run smoothly on its own. If the roller sticks, a rubber hammer is used to loosen it from the tube wall.

To test miscibility two 40 g samples of each of the two greases to be tested are mixed together and introduced into the cylindrical tube as indicated above.

After free and smooth rotation has been ensured, the cylindrical tube is set on to the rollers. If testing is to be at ambient temperature, the roller mechanism is switched on. If the test is to be carried out at a higher temperature, the test apparatus is first heated to the desired temperature and only then is the cylindrical tube inserted and the roller mechanism switched on (160 r.p.m.).

The duration and temperature of the rolling test is taken from the respective standard of requirements or specification. With lithium greases the test is preferably carried out for 24 hours at 110°C.

After the specified time period has passed, the cylindrical tube is taken out and unscrewed. Three samples are then removed :

- the first sample from the middle of the wall of the hollow cylinder,
- the second sample from the middle of the wall of the roller and
- the third sample is prepared from a mixture of equal parts of sample 1 and sample 2.

The churned grease is spread into the test beakers for measuring quarter cone penetration and cooled in them. To accelerate the cooling process the beakers are placed on a cold metal plate.

The drop point of the samples described above is determined in accordance with ISO 2186.

5 - PRESENTATION OF THE RESULTS

The arithmetic mean is formed from the three individual measurements. The penetration values and drop points before and after the rolling test are given together with the test temperature and test duration. If required, the change of the values compared with the reference state is calculated.

Penetration beyond 100 x 0.1 mm is disregarded.

6 - TEST ERRORS

The repetition and dispersion conditions of the respective standards apply.

French National Railways Rolling Stock Department Research Institute	Grease testing machine Control of flow behaviour	MEV NM 86020

"ROPECS"
(Rotation, constant Pulsation, Shocks)

1 - TEST OBJECTIVE

Control of the flow properties of a grease intended for the lubrication of axle-boxes for railway vehicles.

2 - TEST PRINCIPLE

An axle-box housing with two self-aligning roller bearings, into which the grease to be tested is spread, is submitted to the following loading :

- Rotation : ω = 152 rad/s (1450 r.p.m),
- Pulsation frequency : approx. 24 Hz ; acceleration $\pm$ 20 m/s^2
- Shocks : 1 per second
  - maximum acceleration measured at the housing : 250 m/s^2
  - minimum acceleration measured at the housing : 100 m/s^2

- Total duration of the test cycle : 76 hours, of which
  - 36 hours forward rotation (1st stage)
  - 4 hours at rest with ventilation
  - 36 hours backward rotation (2nd stage)

The rotation of the bearings causes the grease temperature to increase ; the combined vibrations (algebraic sum of constant pulsation and shocks) can change the mechanical strength of the soap base. With the softening of the soap base the grease penetrates the seals and flows into the containers. This loss of grease is even accelerated by the intermediate rest period with simultaneous cooling. In the second test stage the expansion of the air forces out the liquid grease in the seals.

3 - TEST PROCEDURE

3.1 - Filling with grease : with pneumatic grease apparatus, 815 g between the two bearings.

3.2 - Forward rotation (1st stage) : pulsation and shocks for 36 hours.

3.3 - Rest period with ventilation : 2 fans with an output of 50 m^3/h for 4 hours.

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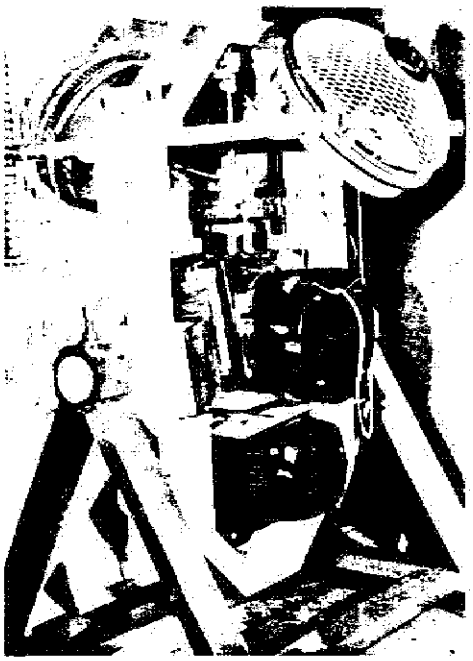
OR
APPENDIX 2

3.4 - Backward rotation
(2nd stage)
- pulsation and shocks for 36 hours

3.5 - Measurements :
- the temperature of the outer rings of the two bearings, the temperature outside the axle-box and ambient temperature are measured throughout the test.

After the test the amounts of grease in the 2 containers and between the bearings are measured.

3.6 - Additional measurements : measurement of the viscosity and the dynamic flow behaviour of the grease with a penetrometer.



General view of the test machine

4 - REJECTION CRITERIA

If the total amount of the grease collected in the 2 channels is $\geq$100 g the grease is rejected.

French National Railways Rolling Stock Department Research Institute	Grease testing machine Control of flow behaviour of greases and the opacity of high pressure additives	MEV NM 86 021

"ROPECACS"
(Rotation, constant Pulsation, axle load, ShockS)

1 - TEST OBJECTIVES

The grease test carried out with this machine in accordance with the method described below makes it possible to check :

- the flow behaviour of the soap base of the grease
- the effectiveness of the extreme pressure additives of the grease
- the suitability of the grease for lubricating bearings.

2 - BRIEF DESCRIPTION OF THE TEST EQUIPMENT

It consists of

-' an axle-box housing with two conical bearings, on to which the grease to be tested is spread and submitted to the following loading :

- Rotation : ω = 152 rad/s (1450 r.p.m.),
- Pulsation frequency : 24 Hz ; acceleration ± 20 m/s^2,
- Shocks : 1 per second
  - maximum acceleration measured at the housing : 250 m/s^2
  - minimum acceleration measured at the housing : 100 m/s^2

- forces exerted on the bearing : with a bearing pressure of 6 bar(1) the axial force amounts to 10.6 kN and the radial force at any point of the bearings to 19.4 kN.
- Total duration of the test cycle : 76 hours, of which
  - 36 hours forward rotation (1st stage)
  - 4 hours at rest with ventilation
  - 36 hours backward rotation (2nd stage)

The rotation of the bearings, the combined vibrations (algebraic sum of the constant pulsation and shocks) and the forces exerted produce
- friction in the shoulder area (effectiveness of extreme pressure additives, shear strength),
- a continuous radial force (lubricating power) and an increase of the grease temperature (overheating resistance and flow behaviour of the soap base).

With the softening of the soap base of the grease the latter passes through the seals and flows into the container. This loss of grease is even accelerated in the rest period with simultaneous cooling. In the 2nd test stage the expansion of the air in the bearing forces out the liquid grease in the seals.

(1) The pressure value specified for this test.

8 1 4 OR

APPENDIX 2

Recording of ambient temperature and the temperature of the outer rings as well as of the power consumed throughout the whole test give an indication of the lubricating quality of the grease and the effectiveness of its additives.

The values recorded are entered into a test log.

3 - TEST PROCEDURE

3.1 Introduction of the grease :

- With a special regulated compressed air pump. Lubrication is obtained by a single injection of the grease contained in the pump (815 g) into the housing through an oil inlet in the bottom part between the two bearings. The time needed to distribute the grease at 20°C is an indication of the suitability of the grease for pumping. (generally 1 - 10 min, but for some greases the distribution time can extend to over 90 min).

3.2 - Forward rotation (1st stage) :
Pulsation, shocks and loading for 36 hours.

3.3 - Rest period with ventilation :
2 fans with an output of 50 m^3/h each for 4 hours.

3.4 - Backward rotation (2nd stage) :
Pulsation, shocks and loading for 36 hours

3.5 - Measurements :

- the temperature, pressure (axial and radial forces) and the power consumed are measured throughout the 76 test hours.

After the test the amount of grease exuded, including any oil loss, is measured, after the grease has degenerated.

3.6 - Additional optional measurements : measurement of the viscosity with a penetrometer, measurement of dynamic flow behaviour and iron content.
3.7 - Test of the bearings after cleaning all components.

4 - REJECTION CRITERIA

4.1 - If the total amount of exuded grease exceeds 150 g, the operating temperature of the bearings exceeded 135°C and the power consumed was more than 2.0 kW, the grease is to be rejected.

4.2 - If the grease tested is intended for the lubrication of bearings for high speed (300 kph), the grease is to be rejected, when only one of the three criteria above has been exceeded.

4.3 - The bearings must show no traces of seizing at their shoulders, inner rings and outer sides of the rollers (effectiveness of additives) and no discolouring of the tracks due to abnormal heating (lubricating suitability).

French National Railways Rolling Stock Department Research Institute	Grease testing machine Strength of lubricants	MEV NM 86019

"MEB"
Housing test machine

1 - TEST BENCH FOR HOUSINGS. GREASES FOR MOTIVE POWER UNITS RUNNING AT 160 AND 200 kph

1.1 - Test objectives :
- Control of the suitability of greases intended for the lubrication of axle-box housings using the MEB machine. Radial and axial loading corresponds to service loading.

1.2 - Brief description of the test equipment
- MEB machine (housing test machine).
- 2 axle-box housings of coaches with 2 bearings each, which are fastened to the ends of a test shaft.

1.3 - Lubrication :
- Grease to be tested.

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1.4 - Loading :

- with the MEB test machine the axle-box housings filled with the test grease are submitted to rotational speeds as well as radial and axial loads, whose magnitude depends on the type of the test grease (for detailed information see §§ 2 and 3) :
- test range : 600,000 km in repeated cycles
- ventilation : 2 fans per housing. Total output per housing : 15,000 m^3/h.
- Air speed : 30 kph. The fans remain switched on during the rest period between two successive tests.

1.5 - Measurements

- temperature of rollers, using a thermocouple, which is brought into contact with the two bearings in each housing.
- temperature in the hot box detection area,
- ambient temperature with the thermocouple in the blown air stream,
- running speed : on the basis of the given wheel diameter (0.840 m) the speed in kph is derived and shown on a digital indicator.
- the power constantly consumed by the whole kinematic chain (motor, driving belts, 2 support bearings, 2 test housings) to permit immediate detection of any anomaly.

APPENDIX 2

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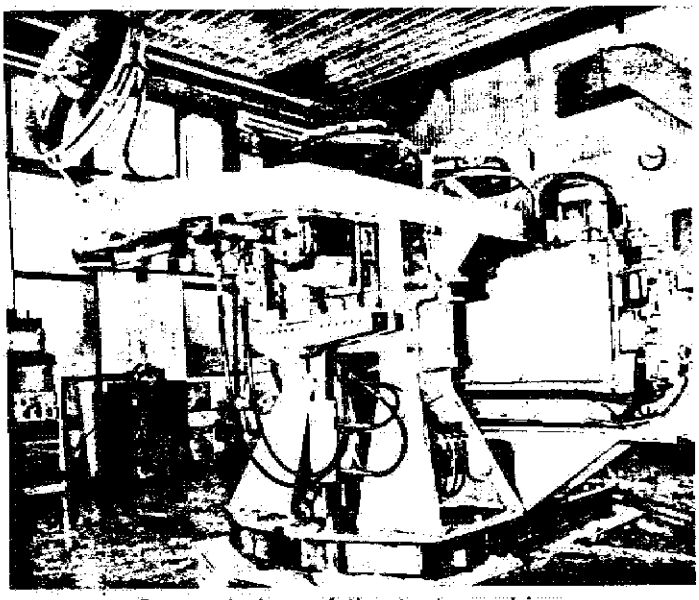

General view of the test machine

2 - GREASES FOR VEHICLES RUNNING AT 160 KPH

2.1 - Bearings used:
two self-aligning roller bearings per housing, two housings are tested at the same time

2.2 - Lubrication :

- 1 kg test grease is packed into each housing, i.e. 350 g into each bearing, 250 g into the cartridge, 50 g into the sealing arrangement.

2.3 - Loading :
- radial force : 85 kN per housing
- axial force : 11 kN with a frequency of 0.1 Hz, duration of application of 4.8 s.

This force is not applied, if the speed is less than 50 kph (starting and retardation periods).
- rotational speed : 104.7 rad/sec, (1000 r.p.m., 160 kph)
- length of cycle : 3h 50 min rotation, 10 min rest with ventilation, then 3h 50 min reverse rotation. One cycle simulates 1184 km.
- test range 600,000 km.

2.4 - Results : see table § 4.

3 - GREASES FOR VEHICLES RUNNING AT 200 kph

3.1 - Bearings used : 2 conical roller bearings with indirect attachment per housing. 2 housings are tested at the same time.
3.2 - Lubrication : 670 g test grease is packed into each housing, i.e. 140 g between cage and inner ring of each bearing, 180 g into the upper half cartridge, 180 g into the lower half cartridge and 30 g into the sealing arrangement.

3.3 - Loading

- radial force : 75 kN
- axial force : 17 kN with a frequency of 0.1 Hz, duration of application of 4.8 s. This force is not applied, if the speed is less than 50 kph (starting and retardation periods).
- rotational speed : 132 rad/sec, (1260 r.p.m., 200 kph)
- length of cycle : 3 h 50 min rotation, 10 min rest with ventilation, then 3 h 50 min reverse rotation. One cycle simulates 1532 km.
- test range 600,000 km.

3.4 - Results see table, § 4.

4-MEB TEST (Housing test machine)

Summary of obligatory regulations

Housing test machine	Obligatory regulations		
	Units	V ≤ 160 kph	V ≤ 200 kph
- temperature of bearing in load range with ambient temperature of 20°C	°C	≤ 100	≤ 65 with 1% tolerance for measurements ≤ 85
- temperature in hot box detection area with ambient temperature of 20° C	°C	≤ 70	≤ 55 with 1% tolerance for measurements ≤ 75
- Deviation of temperatures measured in the load range throughout the same cycle	°C	≤ 15 with a tolerance of 1% for measurements ≤ 25	
- maximum temperature deviation between two successive cycles		≤ 10 with a tolerance of 1% for measurements ≤ 15	
- appearance of the bearings	The rollers and rings must not show any defects, such as chipping, seizing, heating. The cages must not show any fractures, cracks, deformation or signs of abnormal wear		
- increase of iron content in lubricant	%	≤ 0.5	

Application

With effect from 1 July 1988.

All UIC railways.

Record references

Heading under which the question has been examined :

- *Question 5/SA/FIC* - Revision of Leaflet 814. "Technical specification for the official testing and supply of greases intended for the lubrication of railway vehicle roller bearing axleboxes".
(Sub-Committee for Specifications : Paris, January 1988).