
**Road vehicles — Brake lining friction
materials — Product definition and
quality assurance**

*Véhicules routiers — Matériaux de friction pour garnitures de freins —
Définition du produit et assurance qualité*

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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15484 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Braking systems and equipment*.

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Introduction

Drum and disc brake friction materials are important functional parts of the wheel brakes. They are pressed against the rotating brake drum or disc by a clamping force applied by the actuating mechanism of the brake during a braking operation. The kinetic energy of the vehicle is thereby largely transformed into heat. The brake pad or lining is of essential importance for the effectiveness and user comfort of the brake system. Disc brake pads consist of the friction material itself, the pad carrier plate and, in some cases, silencing parts, pad wear warning devices and retaining or guiding elements. The friction material is usually permanently bonded to the backing plate by a bonding process in which the friction material is subjected to both heat and pressure. Underlayers can be inserted between the friction material and backing plate to improve bond strength and other properties. Drum brake linings consist of the friction material itself, usually shaped to match the radius of the brake shoe onto which it is subsequently attached. The friction material is usually attached to the supporting brake shoe either by bonding or by the use of rivets. Conventional friction materials consist mainly of fibrous materials, bonding agents, anti-seize agents, metals and other fillers. The friction material type, and any backing plates, anti-noise measures, pad springs and pad wear warning devices, etc., are defined in the relevant figure.

The basic aim of this International Standard is:

- to ensure the product is verified and validated during all project phases for transfer into series production;
- to increase product reliability and at the same time limit the cost of testing;
- to identify the necessary test standards to equally cover brake performance and noise.

Visibility of production spread and the opportunity to select parts for testing from assorted areas of compressibility are the main reasons for the statistical evaluation. The procedures described in this International Standard are based on ISO/TS 16949 and encompass the entire product quality preplanning process, from the definition phase up to the determination of parameters for series production. These are defined in this International Standard as phases 1 to 7.

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Road vehicles — Brake lining friction materials — Product definition and quality assurance

1 Scope

The procedures in this International Standard apply to disc brake pads and drum brake linings for motor vehicles and describe systematic processes for the quality assurance of such brake linings.

In conjunction with tolerance ranges, the test methods and results described in this International Standard permit a rapid assessment of disc brake pads.

Uniform handling of the procedures through various phases ensures that the quality assurance requirements are clearly understood and that a global implementation is possible in the relationship between customers and suppliers.

This International Standard relates to the completed friction material and is applicable during product development to the quality assurance of ongoing series production, focussing on the “component” friction material. It is advisable that tests with apparent “system” character be avoided.

Raw material checks and processing control are outside the scope of this International Standard.

2 Normative references

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

ISO 2812-1, *Paints and varnishes — Determination of resistance to liquids — Part 1: Immersion in liquids other than water*

ISO 6310, *Road vehicles — Brake linings — Compressive strain test method*

ISO 6312, *Road vehicles — Brake linings — Shear test procedure for disc brake pad and drum brake shoe assemblies*

ISO/PAS 22574, *Road vehicles — Brake linings friction materials — Visual inspection*

ISO 26865, *Road vehicles — Brake lining friction materials — Standard performance test procedure for commercial vehicles with air brakes*

ISO 26866, *Road vehicles — Brake lining friction materials — Standard wear test procedure for commercial vehicles with air brakes*

ISO 26867, *Road vehicles — Brake lining friction materials — Friction behaviour assessment for automotive brake systems*

ISO 27667, *Road vehicles — Brake lining friction materials — Evaluation of corrosion effects on painted backing plates and brake shoes*

JASO C458-86, *Test procedure of pH for brake linings, pads and clutch facings of automobiles*

JIS D 4311, *Clutch facings for automobile*

JIS D 4421, *Method of hardness test for brake linings, pads and clutch facings of automobiles*

SAE J2598, *Automotive disc brake pad natural frequency and damping test*

SAE J2694, *Anti-noise shims: T-Pull test* ¹⁾

SAE J2707, *Wear test procedure on inertia dynamometer for brake friction materials*

SAE J2724, *Measurement of disc brake friction material underlayer distribution*

3 Terms and definitions

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

3.1 density

ρ
ratio of the mass to the volume of the friction material under normal conditions

3.2 porosity

P
relative volume proportion of cavities in a material

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NOTE This includes open or enclosed pores of any size, shape and distribution.

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4 Symbols and abbreviated terms

Symbol	Definition	Unit
ρ	density	g/cm ³
ρ_{net}	absolute or real density without pore volume	g/cm ³
m_{a}	pad mass in air for density measurements	g
m_{w}	pad mass in water for density measurements	g
V	pad volume for density measurements	cm ³
P	porosity	%
T_{R}	room temperature	°C
p_{B}	brake pressure	kPa
M_{d}	torque	Nm
W_{B}	pad wear	mm/g
W_{s}	disc wear	mm/g
μ	coefficient of friction	—

1) In preparation.

5 Product quality preplanning and test plan

5.1 General

The test requirements for the various phases are defined in the different test plans for passenger cars and commercial vehicles in 5.4.

The development phase of prototypes (phases 1 to 4) describes the systematics and tests used in the manufacture of brake linings from tools not yet meeting series standards. The end of phase 4 is the technical product release.

The production transfer and initial sampling (phases 5 and 6) describes the required scope of testing for the assessment of the initial production series with the tools and processes intended for the series.

The validation of the manufacturing process is proven by documentation and assessment of the results during initial series production (phase 6).

The test volume during the continuing series production monitoring (phase 7) lies within the responsibility of the pad manufacturer and is documented in the control plan (CP) which also includes the details for the in-process inspection as well as for the incoming inspection of purchased parts like raw materials, backing plates, shims and accessories.

Based on the level of in-process controls, the test efforts on the final product should be minimized and some tests, such as friction tests, may not be needed for each single batch. In any case, the frequency and sample size has to be defined in the CP.

The chemical-physical brake lining data of the tests listed below include performance and/or characteristic data which result from a process chain. Any requirements of process capability indices and statistical process control need to be agreed between the customer and the supplier. Agreed tolerances, however, have to be respected.

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5.2 Procedure

5.2.1 General procedure

The approval of brake linings is made by vehicle testing and a concurrent determination of its properties by the test standards listed here.

The manufacturer of brake linings ensures that the parameters, the composition and the monitoring of the specified process parameters are maintained by regulated and auditable procedures.

The determination of performance data via the test standards listed here at the end of this process chain and comparison with the tolerance serves as confirmation that the prescribed procedures were correctly performed.

The time delay between processing and testing does not permit process intervention such as SPC (statistical process control).

Determination of performance data on completed brake linings during a batch test serves as continuing proof of conformity and permits the observation of trends.

The tolerance range for these data is determined as described in 5.2.2 to 5.2.5 below.

5.2.2 Prototyping — Customer samples (phase 4)

Initial specification of tolerances are determined from the values of the batch tests of the prototype sampling. The assessment takes account of the data of the variant then approved. The tolerances arising from the approved prototypes are registered in the lining data sheet (LDS).

5.2.3 Specification/validation (phases 5 and 6)

Results are obtained from the batches of the product transferred to series production, under the condition that the composition, the process, the brake, disc or drum and geometry are determined and comply with the state of the series. The results are verified with the customer. Variations to the tolerances shall be agreed with the customer and results shall be recorded on the lining data sheet (LDS). Specifications of tolerance are agreed with the customer viewing the data, using statistical analyses as appropriate.

5.2.4 Series monitoring (phase 7)

The ongoing surveillance of the series production (phase 7) shall be in accordance with the test frequencies and sample size which are fixed in a control plan by the manufacturer based on the process controls on series production.

5.2.5 Review of tolerance

A review of the tolerance following a number of batch tests to be determined can be performed by the friction material manufacturer and the customer.

5.3 Phases of product quality preplanning

The phases of product quality preplanning are shown in Figure 1.

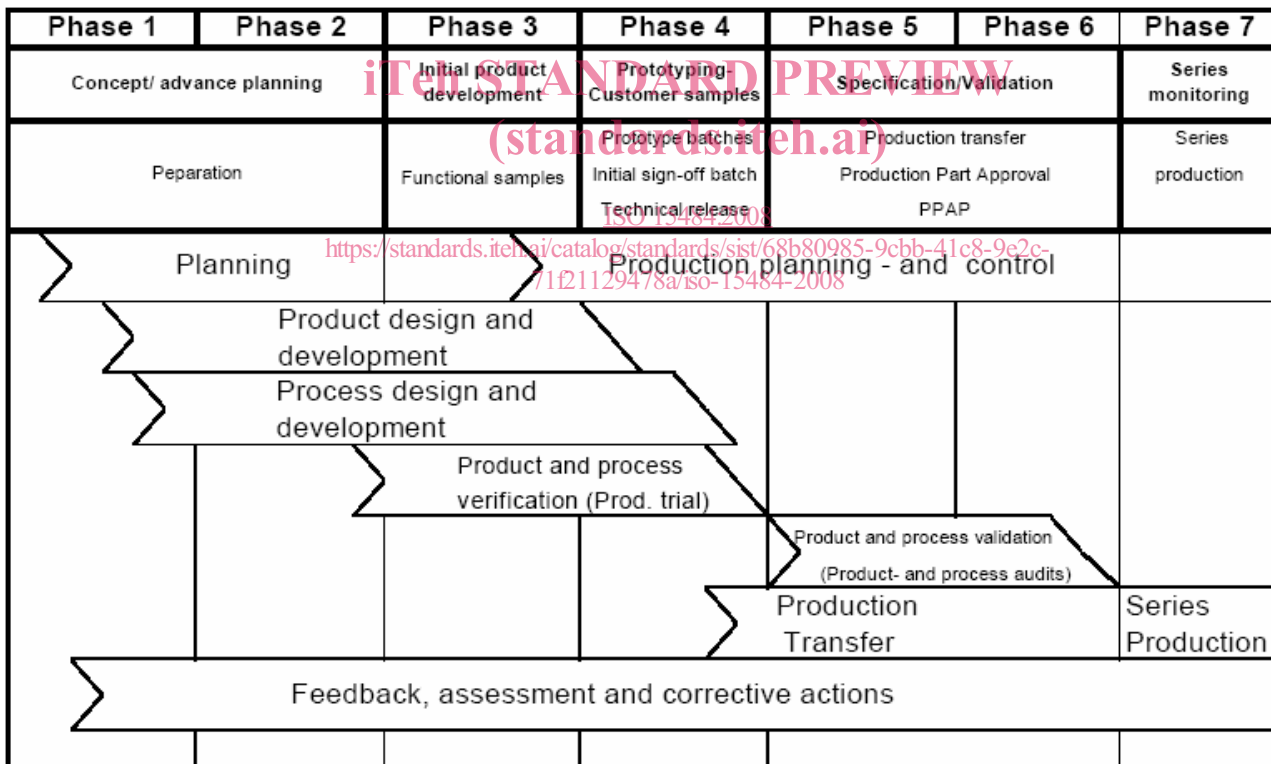


Figure 1 — Phases of product quality preplanning

5.4 Test plan

5.4.1 General

Separate test plans are made for passenger cars and commercial vehicles. The test plans differentiate four basic categories of tests:

- a) general;

- b) physical properties;
- c) corrosion;
- d) inertia dynamometer tests.

This International Standard defines preferred test procedures. Because of established databases and practices, alternative and regional tests are accommodated in the test plans. The companies working in another region should respect local practices. The future goal is the complete harmonization of the test procedures.

5.4.2 Test plan for passenger car disc brake pads

The test plan for passenger car disc brake pads is shown in Figure 2.

Test plan for passenger car disc brake pads				Phase 1 / 2	Phase 3	Phase 4		Phase 5 + 6	Phase 7	
				Concept / advance planning	Initial product development	Prototyping - Customer samples				Specification/ Validation
Type of tests	Notes	Standard/ Document	Index	Preparation	Functional samples	Prototype batches	Initial sign-off batch	Production transfer	Series production	
General										
visual inspection		ISO/PAS 22574	D		100%	100%	100%	100%	C	
underlayer distribution		SAE J2724	D		3/3	3/3	3/3	3/3		
inspection critical dimensions		Part drawing	D		2/2	5/5	5/5	5/5	C	
full dimensional inspection	1	Part drawing	D					5/5		
Physical Properties										
density		ISO 15484	E		3	3	3	3		
porosity		ISO 15484	E		3	3	3	3		
pH-Index		JASO C458-86	E		3	3	3	3		
compressibility, cold	2	ISO 6310	A, D	Kick-off Meeting	50/50	50/50	50/50	50/50	C	
compressibility, hot		ISO 6310	D		2/2	2/2	5/5	5/5		
swell and growth 1		ISO 6310	D		2/2	2/2	5/5	5/5		
thermal transmission		ISO 6310	D		2/2	2/2	5/5	5/5		
shear strength, cold		ISO 6312	A, D		5/5	5/5	5/5	5/5	C	
shear strength, cold (after performance dyno test)		ISO 6312	A, D		1/1	1/1	3/3	1/1		
T-pull-test (bonded insulator)		SAE J2694	D, G		2/2		2/2	2/2	C	
eigenfrequency		SAE J2598	D, G				3/3	3/3		
Alternative/regional tests										
swell and growth 2 (oven)	2	SAE J160	A, D		2/2	2/2	2/2	2/2	2/2	
hardness	2	JIS D4421	A, D	50/50	50/50	50/50	50/50	50/50	C	
Corrosion										
corrosion effects on painted backing plates & shoe	3	ISO 27667	E, F					1 x 3		
resistance to brake fluid and mineral oil	3	ISO 2812-1	E, F					1 x 3		
Inertia-dynamometer tests										
performance test 1/ production friction test		ISO 26867	A, D		1 Br. Set	1 Br. Set	3 Br. Set	1 Br. Set	B / C	
wear test	3	SAE J2707	D, H			1 Br. Set	1 Br. Set	1 x 1 Br. Set	B	
Alternative/regional tests										
performance test 2		SAE 2522	A, D		1 Br. Set	1 Br. Set	3 Br. Set	1 Br. Set	B	
performance test 3		JASO C-406	A, D		1 Br. Set	1 Br. Set	3 Br. Set	1 Br. Set	B	
production friction test		ECE R 90/Annex 8	A, D		1 Br. Set	1 Br. Set	3 Br. Set	1 Br. Set	C	
Optional Inertia-dynamometer tests										
noise matrix dyno test		SAE J2521	D			1 Br. Set	1 Br. Set	1 Br. Set		
Description:					Results of each batch			each Batch		
LDS	Lining Data Sheet				LDS	LDS / MSDS		LDS	LDS	
MSDS	Material Safety Data Sheet				Friction Material Specification			Parameter fixing	Drawing	

- Index:**
- A The values so designated are to be shown as a trend representation starting from phase 5
 - B Within a Product audit as per manufacturer's control plan
 - C Frequency and sample size as manufacturer's control plan
 - D Tests with new linings from each part number
 - E Tests with new linings from inner or outer side
 - F General process/machine tests with new linings from inner or outer side (n/n), not for each part number
 - G All pads for noise dyno tests
 - H Selection of wear test option in agreement with customer

- Notes:**
- 1 Full dimensional inspection only for PPAP (initial sampling)
 - 2 Evaluation of statistical distribution; samples for further tests to be derived from statistical distribution
 - 3 1 test during production transfer, primarily the first batch

Remarks:

Test quantities are valid for each part number ! Separate for inner and outer pads.
 PPAP (Initial sampling) could be in-between or after Phase 5+6.
 The a.m. sampling quantities are the sufficient requirements. For prototypes, the sample can be reduced if there is a proven shortage of parts.
 For repeated sampling also tests can be left out, e.g. SAE J2707 wear testing.
 The complete test plan applies to new products or to friction material changes in existing products.

Figure 2 — Test plan for passenger car disc brake pads