

Technical Specification**TV – 02023-EN**

Title	Technical Cleanliness Requirements for Components and Assemblies of Vehicle Steering Systems
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Preface

Standardization is the objective of the technical regulations. An identical structure of machines and systems in a simple and uniform manner shall thereby be achieved .

The TV (Technical Regulation) is the basis for each project. Any variation must be discussed with the appropriate TK-Presta department and a reason described in the project specifications.

Written confirmation for the release of the variation by the responsible department and the project manager is absolutely mandatory.

The Document "Komponentenfreigabe Systemtechnik _ FS03023-DE" [Component release, system engineering]) has to be used.

2 Informative elements

2.1 Regulatory responsibility, contact persons

The regulatory responsibility contact persons are mentioned in standard form "FS-03323-DE _List of Documents.xls" under "Responsible Person" and "Department".

2.2 Additional effective documents

The additional effective documents are specified on the form „ FS-03323-DE_List of Documents.xls"

2.3 Revisions

2.3.1 Release 1.0 Index A First Issue, dated 13.01.2010, created by Dr. Peter Sowa and Renate Bröer

2.3.2 Release 1.0 Index B, dated 05.10.2010, created by Dr. Peter Sowa and Renate Bröer

Modifications: Extension of the technical specification from electrical steering systems to vehicle steering systems

2.3.3 Release 2, dated 21.07.2011, created by Peter Sowa and Renate Bröer

Modifications: Only the layout has changed. None modifications of the textual content compared to Release 1.0 Index B.

3 Purpose

These technical provisions describe the cleanliness requirements for assemblies and components for ThyssenKrupp Presta Steering vehicle steering units and for the execution of the cleanliness analyses in the state of delivery.

The cleanliness requirement for packaging to be used is also defined. Furthermore, these technical provisions include the tasks and duties of providing proof of component cleanliness for the stages of pre-production, through sampling inspection to serial production and describes proof and its documentation.

The specifications are based on VDA 19 and ISO16232.

The delivery specification LV07200010 "Cleanliness Requirements", which is also active at the time being, remains valid for existing inventory of hydraulic steering systems. For all new developments, the specification TV 2023 must be applied.

4 Scope of Application / Duration of Validity

The technical provisions apply to all components and assemblies for steering gears that include a note that names these technical provisions in their drawings.

These technical provisions are to be treated with the same care and confidentiality as the respective drawing. They must not be passed on to any third parties without the consent of ThyssenKrupp Presta Steering.

5 Terms

Component	Single component of a unit that can not be disassembled any further.
Assembly	Assembly (Zusammenbau; ZB) of several single components in a unit.
ZB steering compl.	Steering assembly complete Mechanic steering gear components incl. engine and electronics components, as well as exterior joints axial and radial joints
Cleanliness category	Cleanliness requirements defined by ThyssenKrupp Presta Steering (combination of cleanliness values / cleanliness level)
Test liquid	Medium for cleanliness analysis that is used for flushing contaminations from a component / assembly.
Particle load	Solid particles at the test surface of an object resulting from the manufacturing process and the environment; where the object is a liquid, these are the particles in the liquid.
Test surface	Partial surface or sum of surfaces of an object that are is or are subject to technical cleanliness requirements.
VDA	Verband der Automobilindustrie(German Association of the Automotive Industry)
VDA 19	Rules for testing technical cleanliness –particle contamination of function-relevant components – Verband der Automobilindustrie e.V. (VDA) Qualitätsmanagement Center (QMC) D-61440 Oberursel, An den Drei Hasen 31 Fax +49 (0) 6171) 9122-14 256 http://www.vda-qmc.de
Cleanliness value	also: Cleanliness level. Value required or determined for a cleanliness feature; e.g. number of particles
Extraction procedure:	Procedure of transfer of as much as possible of the particle load from the test surfaces to the test liquid for metrological analysis.

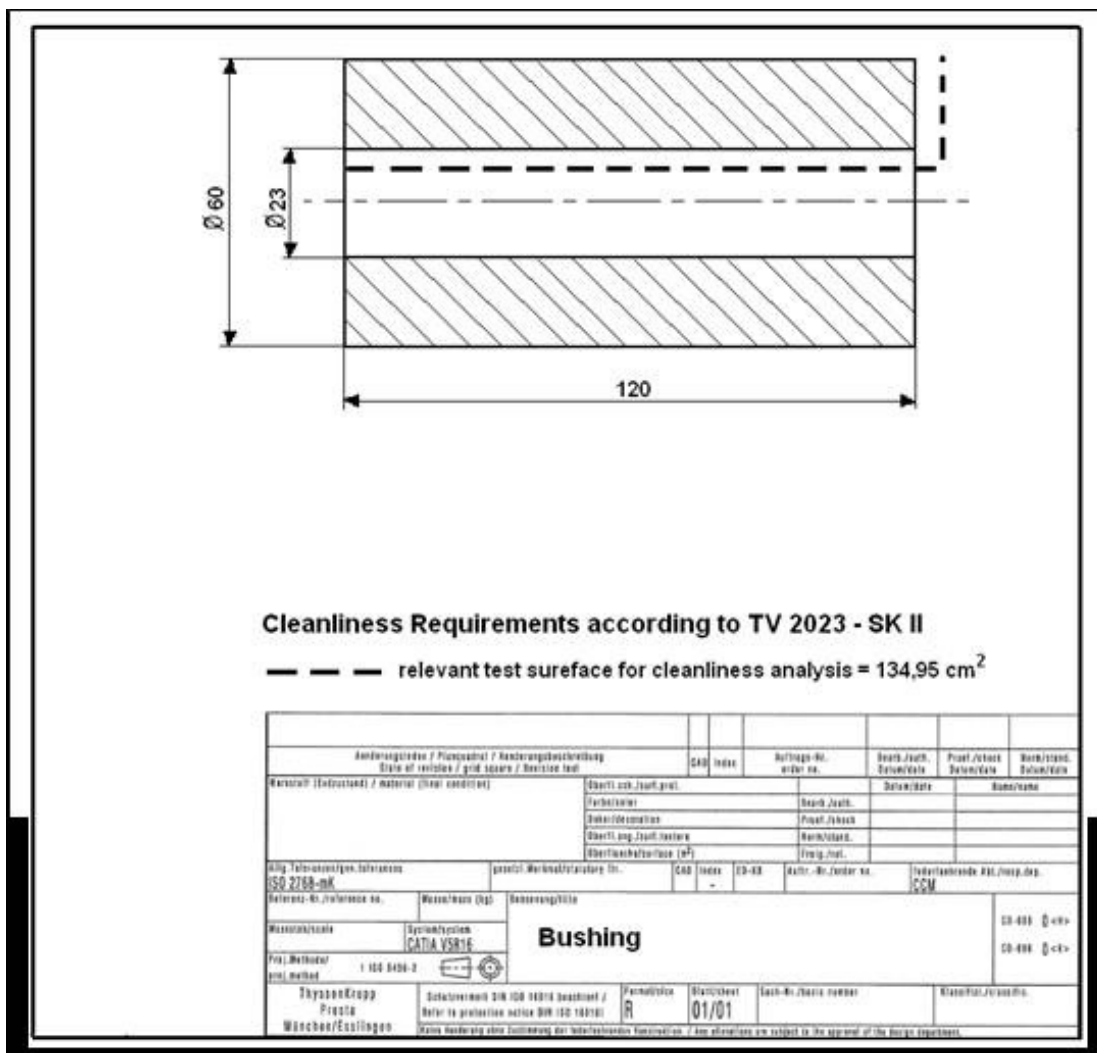
6 Responsibilities

The supplier is responsible for complying with component and packaging cleanliness as required. He must take all measures required for ensuring component cleanliness until the components are delivered to the receiving plant. He must be able to give information on the cleanliness state of the components / assemblies at all times with the help of respective documentation. He needs to set up the processes required for this.

7 Cleanliness Requirements as Entered into Drawing

The required cleanliness category (Cleanliness Categories Tab.3 under 7.2.3) can be gathered above the title block according to figure 1. The test surface relevant for the cleanliness analysis is marked with a thick continuous or dot-dash line (as per DIN ISO 128-20) and the area is indicated in cm². (example figure 1)

Figure 1 Example: Drawing entry of cleanliness requirements and relevant test surface



Printout is uncontrolled and is only for reference.

8 Planning of Test – Time of Test

Pre-Production Stage

Parts with a cleanliness requirement in their drawings must also be delivered and packed with a cleanliness certificate according to these specifications during the pre-production (trial) stage. If this is not possible for reasons of time, lack of equipment or other reasons, the supplier needs to make the respective agreement with the respective contact of the ThyssenKrupp Presta Steering development section.

Sampling Inspection for Serial Production / Initial Sample Inspection

The cleanliness requirements are to be considered like any other component specification. Therefore, analyses must be performed and documented in the initial sampling documents. This applies both to components and the respective serial packaging. If the serial packaging is not yet defined / present at the time of initial sampling, the supplier must include a conception with the initial sampling documentation to show how compliance with the cleanliness requirements is to be ensured for serial supply. When the transfer to serial packaging is made, the respective proof must be filed subsequently. Only clean packages may be used for shipping. The supplier is responsible for using clean packaging.

Under the aspect of cleanliness, initial sampling documentation should include at least the following:

- Applied cleanliness test procedure
- Number of parts tested
- Qualification test results
- Cleanliness test result
- Test / procedure instructions for cleanliness monitoring in serial production
- Proof regarding the cleanliness state of serial packaging

Serial Production

The supplier ensures that the cleanliness requirements are complied with. The required performances are to be documented by the respective work, procedure and testing instructions. Measurement and test results are to be kept according to quality-control provisions and to be submitted to ThyssenKrupp Presta Steering on request. Where the supplier determines any deviations from the agreed-upon cleanliness provisions for the parts to be supplied, the respective improvements are permitted. However, it must be ensured that this improvement will not impair any function of the component/assembly.

The supplier must ensure that a packaging suitable for component cleanliness is used.

9 Preparation of Performance of Cleanliness Test

9.1 Test Procedure

The selection of a test procedure mostly depends on the component/assembly, material and type and amount of particles to be examined for determination of technical cleanliness.

A procedure according to the specifications of VDA 19 is to be used. The E1 "spraying" procedure is recommended, but other procedures are possible in coordination with the ThyssenKrupp Presta Steering. This is a procedure where defined components/assemblies are flushed with a solvent (test liquid) and the particles taken up by a filter in the process are evaluated by a stereo microscope.

For a more detailed explanation of the analysis procedure, refer to VDA 19.

9.2 Cleanliness Categories Definition

In the following, the cleanliness categories defined by ThyssenKrupp Presta Steering are described that apply for the components/assemblies according to requirements and function.

The maximum values for the permissible particle sizes and numbers per component surface of 1000 cm² are defined according to the note in the drawing, which includes the name of the technical provisions (TV-2023 - Technical component/assembly cleanliness for vehicle steering systems) and the cleanliness categories SK I to SK VI.

The determination of cleanliness categories is based on the particle size categories and particle concentration categories.

9.2.1 Particle Size Categories

The particle size distribution is indicated in size categories according to VDA 19 and ISO 16232.

Tab. 1 Particle Size Categories

Size Class (Größenklasse)	Größe x [µm]
E	$50 \leq x < 100$
F	$100 \leq x < 150$
G	$150 \leq x < 200$
H	$200 \leq x < 400$
I	$400 \leq x < 600$
J	$600 \leq x < 1000$
K	$1000 \leq x$

Partikelgrößenklassen nach ISO 16232-10

9.2.2 Cleanliness Categories SK I to VI

The cleanliness categories SK I to SK VI are presented in table 3 and describe the maximum permissible total numbers of particles and particles with metal gloss for the respective size categories according to tab. 2. The amount of particles with metal gloss is a partial amount of the total number of particles.

Evaluation with an automatic evaluation system (e.g. by Jomesa company), which first records the total number of particles with an image processing system and then uses a polarizing light source to determine the particles with metal gloss is recommended.

Other procedures are possible, but should be coordinated with ThyssenKrupp Presta Steering.

The required cleanliness categories for the components/assemblies are determined in the respective drawings.

Tab 2 Cleanliness Categories SK and max. particle number per 1000 cm²

Cleanliness-Category	Particle Type	K > 1000 µm	J 600 – 1000 µm	I 400 – 600 µm	H 200 – 400 µm	G 150 – 200 µm	F 100 - 150 µm	E 50 – 100 µm
SK								
I	total*	1	8	8	64	130	250	1.000
	metallic**	0	0	1	16	32	64	130
II	total*	4	16	32	250	500	1.000	4.000
	metallic**	0	0	2	64	130	250	500
III	total*	16	32	130	1.000	2.000	4.000	16.000
	metallic**	0	0	4	250	500	1.000	2.000
IV	total*	16	32	500	4.000	8.000	16.000	64.000
	metallic**	0	1	8	1.000	2.000	4.000	8.000
V	total*	32	64	2.000	16.000	32.000	64.000	250.000
	Metallic**	1	2	16	2.000	4.000	8.000	16.000
VI	total*	32	64	8.000	64.000	128.000	250.000	1.000.000
	metallic**	1	4	32	4.000	8.000	16.000	32.000

*total max. permissible number of all particles per size category, coded according to table 2

**metallic max. permissible number of particles with metal gloss among them, coded according to table 2

10 Performance of Cleanliness Test

Cleanliness tests are performed pursuant to VDA 19 Prüfung der Technischen Sauberkeit – Partikelverunreinigung funktionsrelevanter Automobilteile – . (verifying technical cleanliness – particle contamination of function-relevant vehicle parts -)

The following procedure must be complied with for this:

Component/assembly cleanliness requirements

Test surface of the component/assembly to be sampled – number of parts to be tested

Requirements for the materials and devices used

Blank determination

Qualification examination and decay behavior / validation of the test procedure

Component cleanliness test

Packaging cleanliness test

Documentation of component and packaging cleanliness and statement of the test results

10.1 Cleanliness Requirements for the Component/Assembly

Cleanliness categories SK I to SK VI are to be taken from the respective drawing.

10.2 Test Surface of the Component/Assembly to be Sampled – Number of Components/Assemblies to be Tested

The test surface relevant for component/assembly testing is given in the drawing.

The numbers of components/assemblies required for concurrent analysis are determined by qualification examination of the test procedure. The criteria for the qualification examination / decay behavior (items 8.4 and 8.5) must be complied with. The required minimum number of components/assemblies to be tested and the procedure is described in VDA 19 chapter D "Qualification Examination and Decay Behavior".

10.3 Requirements for the Materials and Devices Used

All the respective materials and devices must comply with the requirements pursuant to VDA 19.

Test Liquid

The test liquid must be suitable to remove the particles from the components/assemblies to be examined to then collect them on the analysis filter. It must not destroy or corrode the filter material and the parts to be tested. The test liquid must comply with a minimum purity according to the cleanliness requirements for

the part to be tested. Test liquid purity must at least comply with classification 12/9 pursuant to ISO 4406. It must not contain any particles > 50 µm.

Recommendation: test liquid De Solv It 1000; A. + E. Fischer GmbH Wiesbaden, Tel 0611 / 9 28 46-01, www.fischer-wiesbaden.de. (observe compliance and purity of the test liquid for the respective application.)

Test Facility

The cleanliness of the testing environment must be adapted to the cleanliness level required by the components/assemblies. This includes the environment as well as all devices, containers, analysis filters, test facilities (e.g. spraying unit, ultrasonic equipment and flushing station), etc.. For this, the analysing room and all components used for analysis are to be cleaned with purified test liquid until the blank value is reached.

Analysis Filter

The analysis filter must be selected so that it matches the test liquid and all solvents or chemicals used for the testing procedure. The analysis filter pore size must be selected so that the particles relevant according to cleanliness specifications are retained.

Recommendation: 5-µm absolute membrane (e. g. cellulose nitrate filter, nylon membrane)

10.4 Blank Determination

Before each test, the testing device must be cleaned and the permissible blank value must be verified. The blank value depends on the cleanliness requirements for the respective test object. In general, the permissible blank value must not be any higher than 10 percent of the required cleanliness value.

Particle count

Blank value	Particle number	≤ 10 % permissible particle number
	Max. particle size	0 particles > 50 µm

10.5 Qualification Examination and Decay Behavior / Validation of the Test Procedure

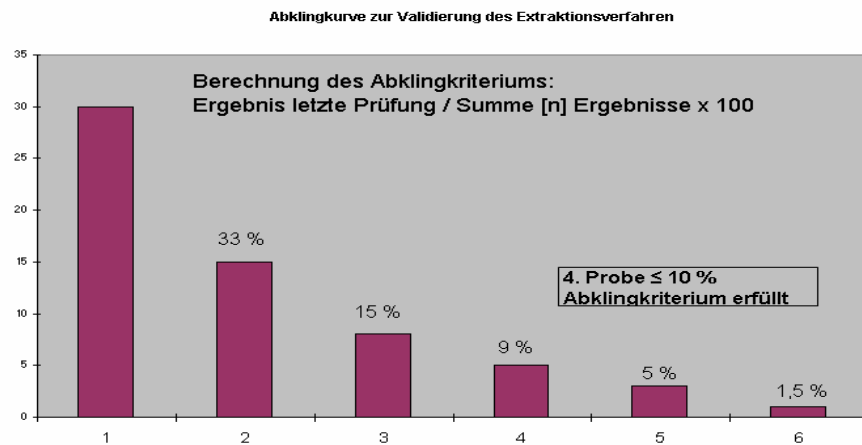
In cleanliness tests, suitable extraction procedures are to be used to determine the particle contamination of cleanliness-relevant areas of components/assemblies. The extraction procedure used must be documented once for each part and component by qualification examinations regarding the effectiveness for particle extraction pursuant to VDA 19.

Decay Measurements

By repeated sampling of the same component/assembly, the suitability of the selected extraction conditions can be verified. The cleanliness values must decrease by defined values.

The measured values of the particle load are recorded and the decay behavior is graphically illustrated (Figure 2).

Figure 2 Decay Behavior (Example)



Decay Criterion ≤10 %

The routine sampling conditions required for reaching the necessary decay behavior are derived from the results; this is, e.g., the total required amount of spray liquid.

The last measured value is divided by the sum of all measured values and the result multiplied by 100. The decay criterion is met when a result of less or equal to 10 percent is achieved within the six samplings.

10.6 Component / assembly Cleanliness Test

The extraction procedure to be used for cleanliness examination is "E1 spraying" acc. to VDA 19. If this procedure cannot be used for reasons specific to the components, the TQUS section of TKPS, Düsseldorf plant must be included in the selection of another, suitable extraction procedure pursuant to VDA 19 (E2 ultrasound, E3 flushing, E4 shaking).

Microscopic Examination with Particle Counting

The particle load collected on the analysis filter is evaluated under a reflected-light stereo microscope. For evaluating if the required cleanliness category is achieved, particle counts are performed for the respective size categories acc. to table 1. For this, the total number of particles is determined, and then used to determine the partial amounts of particles with metal gloss. The values resulting from this are used to

calculate the particle concentration per 1000 cm². Values are rounded to whole numbers. The particle concentration category is determined pursuant to tab. 2.

Recommendation: Use automated counting procedures for counting particles (e.g. microscope with particle evaluation system, Jomesa)

10.7 Packaging Cleanliness Test

Packaging is to be considered a part of the component/assembly. The same cleanliness requirements apply for it. They must generally be proven by the same procedure. To limit effort, time and costs, the following states three test methods for quick and easy verification of packaging cleanliness. The extraction procedure methods are binding, but usually ThyssenKrupp Presta Steering will accept the quick test procedure. A corresponding packaging cleanliness quick test is to be performed in addition to each component cleanliness test and to be documented correspondingly in the component documentation.

Sampling of component and packaging in a ready-for-shipping state is performed accordingly.

Using proper packaging, the supplier is to ensure that the parts to be supplied are delivered in the purity state defined in "TV-2023 Technical component/assembly cleanliness for vehicle steering systems".

10.7.1 Cleanliness quick test for direct packaging

Direct packaging is the packaging directly enclosing the component/assembly. Indirect packaging is packaging enclosing the component/assembly packed in its direct packaging.

The following cleanliness quick tests must be performed for direct packaging as well for each component/assembly cleanliness test. Apart from the "Visual Evaluation", also the "Wiping Test" and the "Adhesive Tape Test" have to be performed.

10.7.2 Cleanliness Quick Test for Indirect Packaging

If the component, e.g. packed in a PE bag, which is again packed into a KLT, the PE-bag is the direct, and the KLT the indirect packaging. The only quick test to be performed for indirect packaging is the "visual evaluation". The test is deemed passed when no loose particles, removable or other contaminations can be seen.

10.8 Cleanliness Quick Tests**10.8.1 "Visual Evaluation" Quick Test**

Packaging is evaluated visually. The test is deemed passed when no loose particles, removable or other contaminations can be seen.

10.8.2 "Wiping Test" Quick Test

For this, a clean, white, lint-free cloth (e.g. Kleenex) is wiped over the inside of the packaging to be tested with light pressure. The test is deemed passed when the cloth shows no perceptible contamination (grey color, dust or single particles) after the test.

10.8.3 "Adhesive Tape Test" Quick Test

For the adhesive tape test, an approx. 10 cm long colorless, transparent adhesive tape is attached to the surface to be tested and pressed on. Then the tape is pulled off and put on a suitable surface (e.g. a white sheet of paper) for examination. The particle size is measured with a measuring magnifier with factor 8 magnification and 100 µm scale gradations. The test is deemed passed if no particles are determined that are larger than the largest particles permissible for the component to be delivered.

11 Documentation of Component/Assembly and Packaging Cleanliness under Statement of the Test Results

The evaluation of each analysis is documented in a report by the relevant laboratory.

The report includes:

1. Reference number and description of the component or assembly.
2. The extraction method used, the flushing medium and flushing volume, the filter used and filter pore size
3. Date and tester's name.
4. Number of tested components or assemblies and tested area per component
5. The required cleanliness category

Result and evaluation

6. Blank test result
7. Numbers of total particles and particles with metal gloss per 1000 cm² area of the respective particle concentration class
8. The largest metallic and non-metallic particles respectively in µm.
9. A conclusive statement about whether or not the values determined are inside the required cleanliness category for the respective particle size categories.
10. Once, the result of the qualification certificate and test / procedure instructions for cleanliness monitoring for serial production must be submitted. This usually takes place with initial sampling.
11. Packaging quick test results

Reports must be presented on the request of ThyssenKrupp Presta Steering. The usual periods for quality documents apply for keeping the documents.

When the permissible threshold values are exceeded, ThyssenKrupp Presta Steering must be informed immediately, and the respective batch must be locked.

12 Joint Documents

ISO 4405
ISO 4406
VDA 19
ISO 16232-10
DIN ISO 128-20