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Introduction

This MAGURA Work Standard (MWN) describes the conditions and regulates the process in determining the particle contamination on components and systems.

Cleanliness testing serves as a basis for evaluating technical cleanliness during the

- incoming and outgoing goods inspection
- quality check of manufacturing processes relevant to cleanliness, monitoring of process steps

The new version of the MWN 1033 replaces all previous versions of this MWN. VDA Volumes 19 "Technical Cleanliness Testing" and 19.2 "Technical Cleanliness in Assembly" are taken into consideration in this MWN.

1 Purpose and Scope of Application

This MWN describes the determination of residual dirt particles on individual parts and in components. In doing so, the existing contamination on the surface and interior of the systems that may result from the manufacturing process and/or the environment should be recorded quantitatively during the cleanliness testing.

It may be that there is increased friction, wear and tear and functional restrictions due to contamination of the components with residual dirt particles from the manufacturing process and/or the environment. The cleanliness of the component used has great significance.

Cleanliness testing takes place by determining residual dirt on the component and in the system according to the process described below.

2 Normative References

The following normative documents contain definitions that are part of the MWN 1033 as a result of being mentioned in this text. The last version of the normative document referred to applies with undated references.

- ISO 16232 — Road vehicles - Cleanliness of Components for Fluid Systems - Part 10 Presentation of the Results
- VDA Volume 19 — Technical Cleanliness Testing - Particle Contamination of Functionally Relevant Automotive Parts
- VDA Volume 19.2 — Technical Cleanliness in Assembly - Environment, Logistics, Personnel and Assembly Equipment

3 Terms

Component	describes all individual parts
System	describes components and assemblies

4 Test Process

Cleanliness testing is carried out in two substeps.

1. In the first step the particles adhering to the component are detached using an extraction process.
2. In the second step the number of detached particles is determined gravimetrically and the detached particles are characterised by means of light microscopy.

The cleanliness of the manufactured component can be impaired by:

- Material removal, e.g. particles from the base material, particles from the tool, separation equipment, processing, etc.
- Captured particles, e.g. improper handling of the component and environmental influences, such as personnel, work clothing, storage surface, ambient air, tools, packaging and testing of the component

The definition of the test procedure is an essential part of the test process in order to avoid the environment influencing the test result.

Sampling must take place in the condition that the product is delivered and supplied.

Efforts must be made to ensure that the sampling and transportation of the samples to the test location are in accordance with cleanliness standards.

The test area must be separated from areas where contamination occurs. The use of compressed air to clean/dry objects should be avoided in the test environment as contamination can be dispersed in the process.

The test object must be tested as a whole. (Special cases must be jointly agreed between the supplier and customer).

Conditioning of the test object is not required for the tests listed below.

A check of the test environment is conducted by means of a blind sample as required.

4.1 Extraction Process

An aqueous solution with the addition of a neutral surfactant-based cleaning agent is a suitable medium for cleaning components.

Note: Thinning agent, benzine, etc. can also be used as cleaning additives (depending on the component).

The following extraction processes are preferred by MAGURA (deviations must be agreed):

- For components ➔ the ultrasonic bath
- For systems ➔ the spraying process

The use of an ultrasonic bath can be provided as an alternative process.

Note: Extraction in an ultrasonic bath is not a suitable process for certain moulded parts (e.g. leaching may occur from the raw material with die-cast components).

4.1.1 Spraying Process

The conditions are described below that must be observed when using the extraction process in combination with the spraying process. Test liquid is applied to the component through an open jet in the spraying process. The cleaning effect is mainly based on the pulse transmission when the jet comes into contact with the component as well as, to a lesser extent, on a part that is being rinsed by the cleaning agent solution.

The spraying process allows different nozzles and operating pressures to be used depending on the geometry of the component in order to achieve an effective detachment of dirt particles.

The areas of the components to be sprayed should be defined by the customer and supplier depending on the end application.

A double determination is carried out.

- So many components are subjected to the extraction process that preferably an area of (100 to 200) cm^2 should be available.
- With systems, only the functionally relevant interior in its assembled state should be rinsed (wetted volume 100 cm^3). The result can be distorted by dismantling the system and subsequently rinsing it.
- The spraying is done in a collecting tray that can fully accommodate the part to be tested and the amount of test liquid used.

- The amount of test liquid required is established from a decay measurement (see Identifying the Decay Curve 4.2). Repeat sampling identifies whether the chosen extraction conditions are suitable. A defined decrease of the cleanliness values must be obtained.
- The test liquid, a solution of neutral surfactant-based cleaning agent in demineralised water, is prefiltered using a filter with a mesh size of 5 µm. A filter with a mesh size of 8 µm should be used for parts contaminated with mineral oil.
- The analysis filter used (mesh size 5 µm) is preconditioned with test liquid. To this end, 100 ml of prefiltered test liquid is drawn over the analysis filter. The analysis filter is dried in a drying cabinet for a period of 60 minutes (constant weight must be given) at a temperature of 80 + 5 °C. The analysis filter is cooled to room temperature in a desiccator for a period of 15 minutes (constant weight must be given).

Note: The preconditioning of the analysis filter to a constant weight is optional.

- The extraction process is carried out at room temperature.
- The extraction container is rinsed once with an adequate amount of test liquid.
- The following pressure conditions are possible:

Undefined low pressure	laboratory spray bottles
Low pressure	up to 1 bar
Medium pressure	from 1 to 10 bar

4.1.2 Extraction Process in an Ultrasonic Bath

The conditions are described below that must be observed when using the extraction in combination with the alternative ultrasonic bath.

Note: The ultrasonic bath is not suitable with systems, as dirt particles from the surface are also released.

A double determination is carried out.

- So many components are subjected to the extraction that preferably an area of (100 to 200) cm^2 should be available.
- The extraction process takes place in a suitable container in which the parts must be completely covered with the test liquid. .
- The test liquid, a solution of neutral surfactant-based cleaning agent in demineralised water, is prefiltered using a filter with a mesh size of 5 µm.
- The analysis filter used (mesh size 5 µm) is preconditioned with test liquid. To this end, 100 ml of prefiltered test liquid is drawn over the analysis filter. The analysis filter is dried in a drying cabinet for a period of 60 minutes (constant weight must be given) at a temperature of 80 + 5 °C. The analysis filter is cooled to room temperature in a desiccator for a period of 15 minutes (constant weight must be given). .

Note: The preconditioning of the analysis filter to a constant weight is optional.

- The extraction process is carried out at room temperature.
- The duration of the extraction process is max. 5 minutes at 30-40 kHz.
- The extraction container and the test pieces contained therein are rinsed once with an adequate amount of test liquid.

4.2 Identifying the Decay Curve

The effect of the extraction process determines whether the cleanliness of a component/system can be correctly evaluated.

As there is no absolute method to determine the particle load that actually exists, decay measurements are carried out in accordance with VDA Volume 19.

Repeat testing of a component/system identifies whether the chosen extraction conditions are suitable for evaluating the cleanliness of the component. A defined decrease of the cleanliness values must be set.

Repeat testing of the component/system checks whether the detached particle load decreases in each case.

A deterioration of the component surface by the extraction process must be prevented to avoid the removal of mixture components that will distort the result of the cleanliness test. As soon as there has been a deterioration of the component surface, the reduction of the cleanliness values can no longer be identified:

The test conditions in 5.1.1 and 5.1.2 are defined with the identification of the decay curve in accordance with VDA Volume 19.

4.3 Blank Value

The blank value represents the additional contamination when testing that can appear from unpacking the component up to and including the analysis of the particle load. The blank value must be identified under the conditions that are also used in the routine testing of the component. Here, the cleanliness testing is carried out without the component.

The blank value should not exceed 10% of the required / anticipated cleanliness value of the component.

4.4 Analysis Methods

This section describes the analysis methods applied to the components/systems in order to examine the cleanliness of the components.

The particles adhering to the component/system are detached from the component surface using the extraction process. The test liquid is filtered through a preconditioned analysis filter with a mesh size of 5 µm under a water jet pump vacuum. It is then rinsed with the test liquid.

The analysis filter, including the residue, is dried in a drying cabinet for a period of 60 minutes (constant weight must be given) at a temperature of (80 + 5 °C). The filter is cooled to room temperature in a desiccator for a period of 15 minutes (constant weight must be given).

The filter residue is analysed.

Two analysis methods that consist of two parts (gravimetric and light microscopy) are used here when evaluating the component/system.

It should be noted that the time and effort incurred for the dirt particle extraction and analysis can lead to considerable investment of time and cost depending on the method used.

4.4.1 Gravimetry

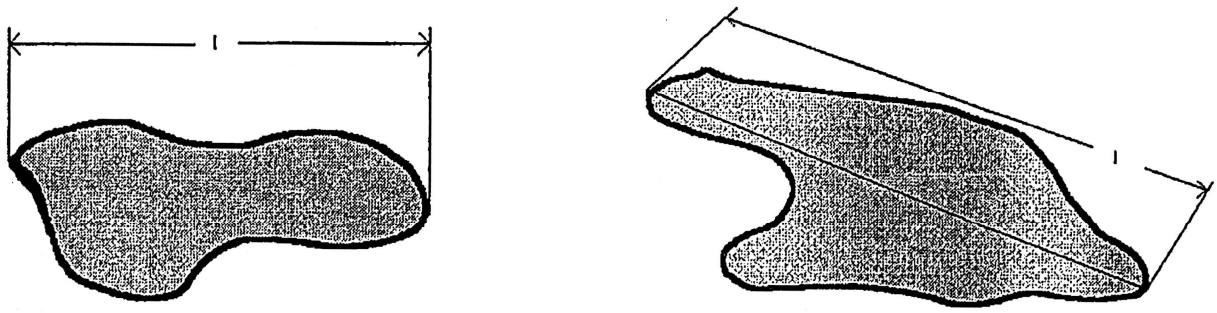
Gravimetry is a quantitative analysis method whereby the measurement of the quantity of matter is based on the determination of the masses. The particle load of the component/system is determined by the increase in mass of an analysis filter. The corresponding analysis filter already addressed in 4.1.1 and 4.1.2 is weighed before and after the filtration of the washing liquid by means of an analytical balance. To this end, an analytical scales with a reading accuracy of 0.1 mg must be employed.

4.4.2 Light Microscopy

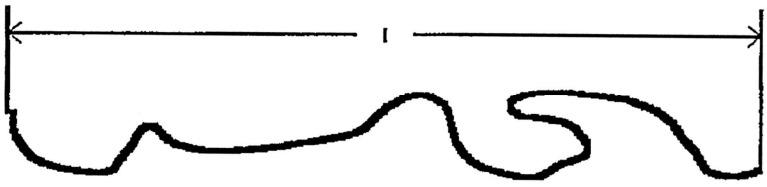
Light microscopy is suitable for evaluating filter residues quantitatively and qualitatively according to 4.3.1. The result of this analysis delivers the number and size of the detected particles on the analysis filter as well as the particle size distribution and the number of residue particles.

Note: If the filter is too heavily charged, an analysis can be inaccurate or even impossible (strong grey colouring of the filter, overlapping of particles, etc.).

The analyses can be carried out manually or fully automatically. The size of a particle is identified by its longest dimension.



Picture 1: Example of particle size determination.



Picture 2: Example of fibre size determination.

5 Documentation

The cleanliness value of a component can be expressed by the residue weight of the particle (gravimetry) and by the size of the largest particle found or, if required, by the particle size distribution (number of particles per size class).

The relevant test parameters and analytical conditions should be documented in a test protocol.

5.1 Presentation of Gravimetric Values

The following information is required when specifying the results of the gravimetric analysis:

- Number (n) of components sampled
- Wetted surface (A, in cm^2) or
- Wetted volume (V, in cm^3)
- Total mass of the extracted particles (M in mg).

5.1.1 Mass per Component

The particle mass per component is calculated as follows:

$$G_C = \frac{M}{n}\left[mg / component\right]$$

The abbreviations have the following meaning:

n The number of components

M The total mass of the extracted particles in mg

5.1.2 Mass per Surface

The particle mass in relation to the surface is calculated as follows:

$$G_A = \frac{M * 1{,}000}{A_C}\left[mg / 1{,}000 cm^2\right]$$

The abbreviations have the following meaning:

A_C The wetted surface of the component in cm²

M The total mass of the extracted particles in mg

5.1.3 Mass per Volume

The particle mass in relation to the volume is calculated as follows:

$$G_V = \frac{M * 1{,}000}{V_C}\left[mg / 100 cm^3\right]$$

The abbreviations have the following meaning:

V_C The wetted volume of the system in cm³

M The total mass of the extracted particles in mg

5.2 Presentation of the Particle Size Distribution (Coding)

The particle size distribution CCC (**C**omponent **C**leanliness **C**ode) is carried out in accordance with ISO 16232-10.

The following presentation thus means:

CCC = A (H2 / I1 / JO)

A component/system with the CCC as described in (2), should include a test area of 1,000 cm^2, 2 - 4 class H particles (200 ≤ X< 400 µm), 1 - 2 class I particles I (400 ≤ X < 600 µm) and 0 - 1 class J particles (600 ≤ X < 1,000 µm).

The abbreviations have the following meaning:

CCC	Component Cleanliness Code
A	Area (to 1,000 cm^2)
V	Volume (100 cm^3)
N	Component/system (1 – n)
B - K	Particle classes in µm
00 - 20	Number of particles per area A and volume V

For "A" and "V" the exact assignment of the particle classes B - K should be taken from table 1 and the exact assignment of the particle numbers 00 - 20 from table 2. For N the exact assignment of the particle classes B - K should be taken from table 1 and the corresponding number of particles is shown uncoded.

Table 1: Definition of the Particle Classes

Particle Class Code	Particle Class in µm
B	5 ≤ < 15
C	15 ≤ X < 25
D	25 ≤ X < 50
E	50 ≤ X < 100
F	100 ≤ X < 150
G	150 ≤ X < 200
H	200 ≤ X < 400
I	400 ≤ X < 600
J	600 ≤ X < 1,000
K	1000 ≤ X

Table 2: Definition of the Particle Count

Particle Count Code	Particle Count
00	0
0	0 < X ≤ 1
1	1 < X ≤ 2
2	2 < X ≤ 4
3	4 < X ≤ 8
4	8 < X ≤ 16
5	16 < X ≤ 32
6	32 < X ≤ 64
7	64 < X ≤ 130
8	130 < X ≤ 250
9	250 < X ≤ 500
10	500 < X ≤ 1,000
11	1,000 < X ≤ 2,000
12	2,000 < X ≤ 4,000
13	4,000 < X ≤ 8,000
14	8,000 < X ≤ 16,000
15	16,000 < X ≤ 32,000
16	32,000 < X ≤ 64,000
17	64,000 < X ≤ 130,000
18	130,000 < X ≤ 250,000
19	250,000 <X ≤ 500,000
20	500,000 < X ≤ 1,000,000

6 Limit Values

A distinction must be made in two areas when describing limit values. The distinction is made by dividing them into components and systems.

The following strictly applies for the limit values that are described in tables 3 and 4:

- Fibres are not generally considered as particles. Fibres that are smaller than 3,000 x 80 µm are not evaluated. If the fibres are larger then they are counted as particles. This definition should be put into effect using the appropriate software design criteria when the evaluation is fully automatic (see pict.2).
- Hard particles (such as metals, hard plastics, other inorganic materials)
  - The limit value is defined by component or system for class 1.
  - For classes 2 and 3, the definition of the limit value for hard particles is carried out in direct agreement with the customer and supplier.
- In a manual evaluation the limit value of the largest permissible particle is taken from the CCC specification.

6.1 Components

Components are all individual parts that are used in the manufacture/installation of assemblies and systems.

Limit value for hard particles CCC = (I-K00). i.e. no particle should be larger than 400 µm.

Table A: Classification for Components

Class	Residual dirt in mg per 1,000 cm^2	CCC
1	≤ 5	A (E10, F9, G6, H4, I0, J00)
2	> 5 ≤ 15	A (E11, F10, G7, H5, I2, J1, K00)
3	> 15 ≤ 30	A (E11, F10, G8, H7, I4, J3, K00)

6.2 Systems

Systems are all assemblies and finished products/spare parts.

Limit value for hard particles CCC = (J-K00). i.e. no particle should be larger than 600 µm.

Table B: Classification for Interior Systems (brake, clutch fittings, etc.)

Class	Residual dirt in mg per component	CCC
1	≤ 5	N (E1000, F500, G64, H32, I4, J-K00)
2	> 5 ≤ 10	N (E2000, F1000, G250, H32, I8, J2, K00)
3	> 10 ≤ 20	N (E2000, F1000, G500, H64, I16, J4, K00)

Table C: Classification for Kit Systems (piston sets, etc.)

Class	Residual dirt in mg per 1,000 cm^2	CCC
1	≤ 5	A (E10, F9, G6, H4, I0, J00)
2	> 5 ≤ 15	A (E11, F10, G7, H5, I2, J1, K00)
3	> 15 ≤ 30	A (E11, F10, G8, H7, I4, J3, K00)

7 Test Frequency

Cleanliness testing on components and systems is carried out at the initial sampling stage in agreement with the supplier and the customer.

Thereafter the given testing type should be repeated periodically at an interval determined by the manufacturer as part of the requalification on components and systems.

8 Drawing entry (examples)

Drawing entry for class 1 components:

MWN-1033-A1 ➔ Herein "A" is Table A: Classification for components (page 10)

Drawing entry for class 1 systems:

MWN-1033-B1 ➔ Herein "B" is Table B: Classification for interior systems (page 10)

Drawing entry for class 1 systems:

MWN-1033-C1 ➔ Herein "C" is Table C: Classification for kit systems (page 11)

Conversion to E-Px described in **LE-12 – Cleanliness requirements of components**

9 Other Applicable Documents

The following documents should be taken into account in addition to the standards and VDA volumes mentioned in "2. Normative References":

P15_Delivery Conditions_D_080312

P15_Packing Instructions_D_080312

MWN 1031

10 Appendix

Example of an evaluation:

Sample Description

General Information

Company	MAGURA
Ref. work instructions	QV34021
Ref. qualification data	MAGURA 1-2007

Test object/component

Component	C-fitting (clutch)
Component no.	000
Sample no.	275
Sampling date	06.04.2011

Sampling

Sampling	Rinse status
Number of components	1
Sampling environment	Not defined
In accordance with ISO 14644-1	Aspirated

Gravimetry

Filter tare weight	62.7mg
Overall filter weight	69.0mg
Amount of residual dirt	6.3 mg

Analysis

Filter no.	275
Filter type	8 µm
Filter size/mm	46.4
Evaluation size/mm	43.4
Measurement µm/pixels	2,60
Test filter	No
Cascade	No
Lighting	Reflected light
Analytical environment	Not defined
In accordance with ISO 14644-1	Rinsed

Tester	xxx
Date	06.04.2011 10:04

Class	Number	Max. number	Fibre	Metal filing	Other
Up to 100 µm	122	5,000	0	0	122
Up to 500 µm	11	1,000	2	0	9
Up to 1,000 µm	3	100	2	1	0
Up to 2,000 µm	4	5	3	0	1
Total	**140**	**6,105**	**7**	**1**	**132**

Largest particle (by type)

Type	Size
Fibre	2,365 µm
Other	1,053 µm
Metal filing	677 µm

Component Cleanliness Code

CCC specification	V(B23/C20/D-K16)
Test batch [number]:	1
Component:	100.0 cm³
CCC measurement	V(B-K8) In order

Size class	B	C	D	E	F	G	H	I	J	K
Size range	5-15	15-25	25-50	50-100	100-150	150-200	200-400	400-600	600-1,000	>1,000
Particles per test batch	0	0	93	29	5	1	4	1	3	4
Particles per 100 cm³	0	0	93	29	5	1	4	1	3	4
Concentration class	00	00	7	5	3	0	2	0	2	2