

Dr. Manuel Ulmer
Senior Consultant

CleanControlling®

Online-Basic-Seminar TECHNICAL CLEANLINESS

VDA 19.1 and VDA 19.2

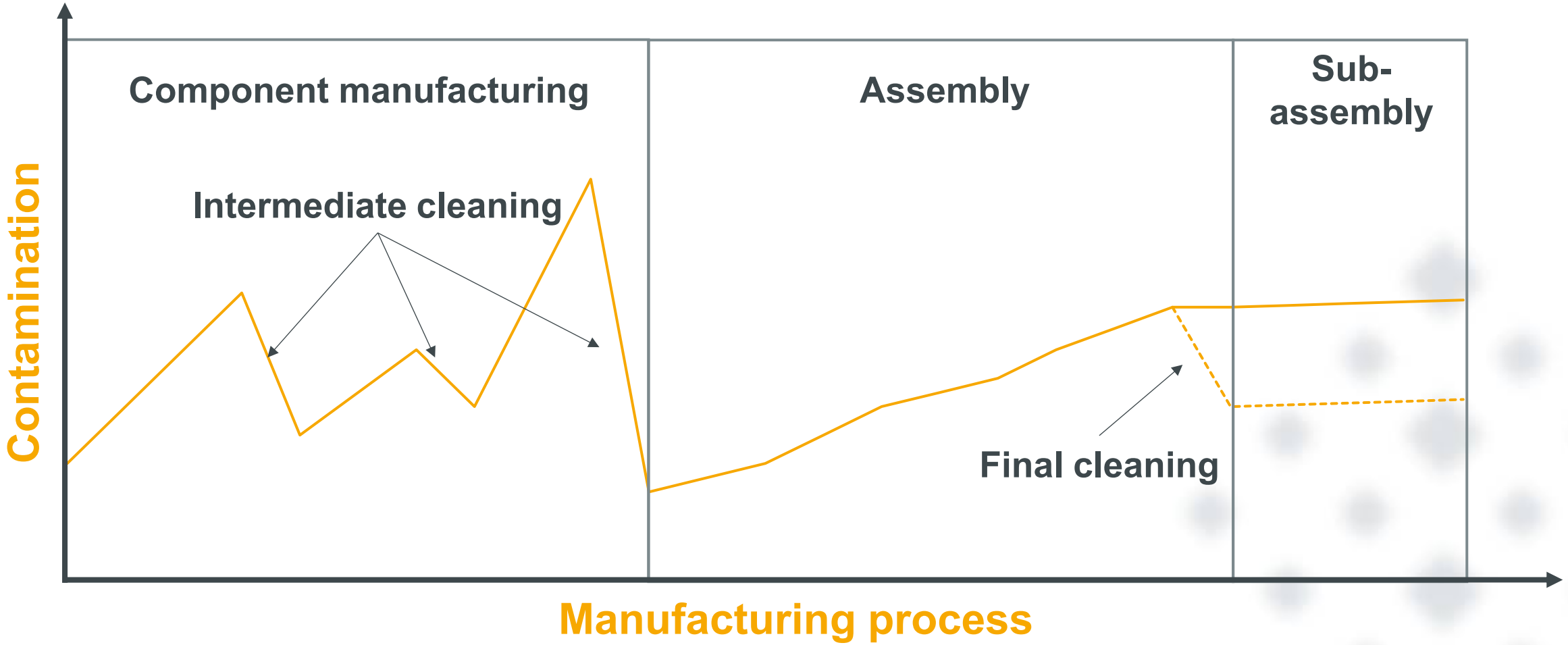


Influence of the environment on component cleanliness according VDA 19 part 2

Dr. Manuel Ulmer, CleanControlling GmbH

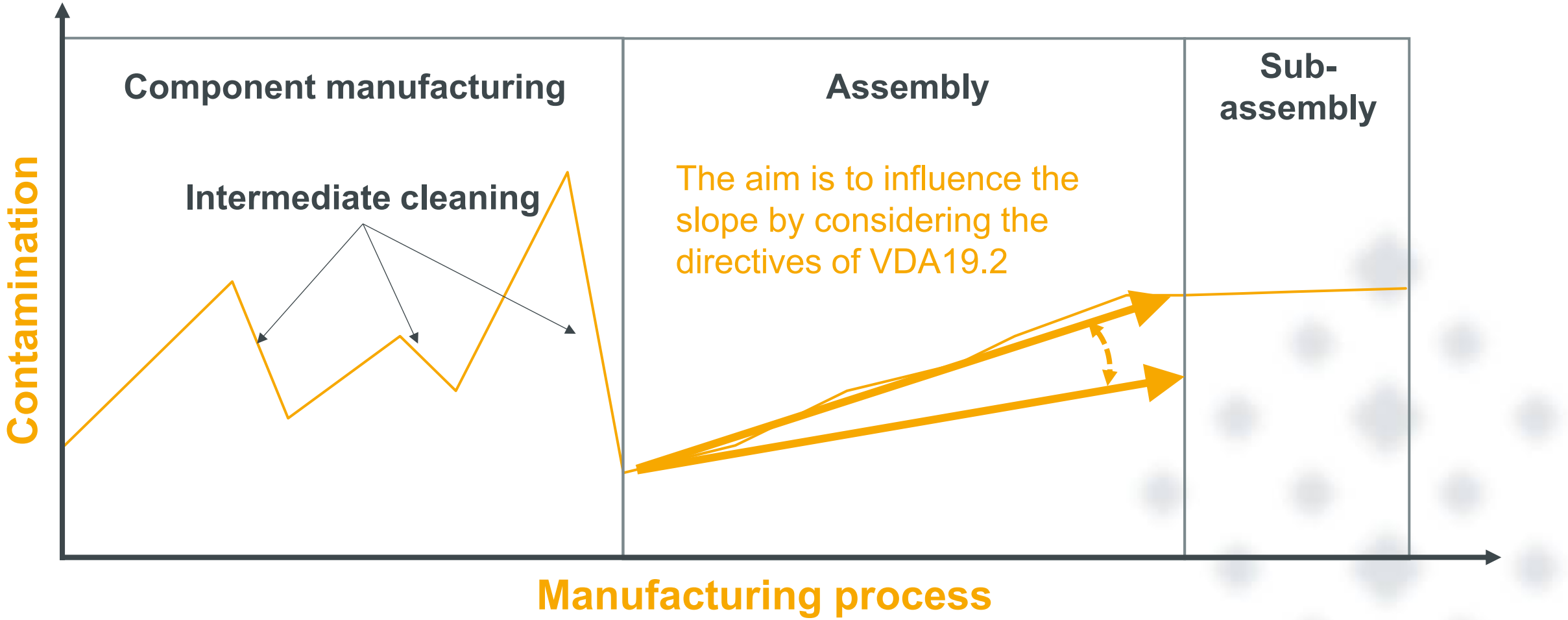
CONCEPT OF A CLEAN PRODUCTION

Requirements and objective



CONCEPT OF A CLEAN PRODUCTION

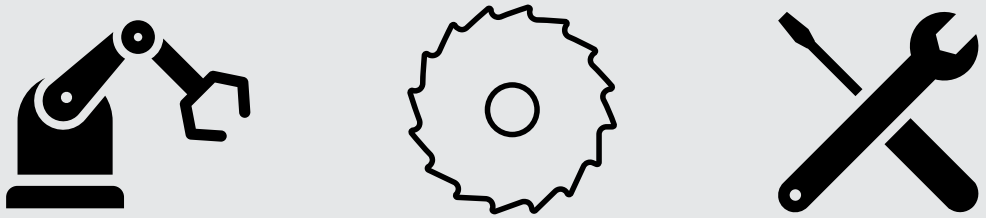
Requirements and objective



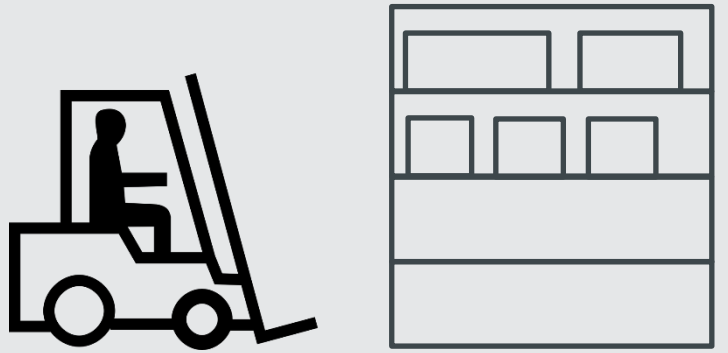
CONCEPT OF A CLEAN PRODUCTION

Overview

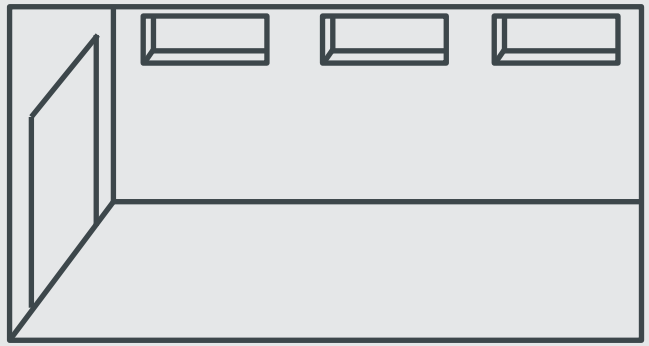
Processes / Production equipment



Logistics



Production environment



Personnel



Particle monitoring



PARTICLE CONTAMINATION ON COMPONENTS

What factors influence the cleanliness of products?

Contamination in the machining process		Particle spreading
~ 80%	~ 40% Single components ~ 40% Process	~ 20%
AVOID	REMOVE	PROTECT

Optimization:

- Geometry of components
- Material selection / pairing
- Process optimization
- Device design

Cleaning:

- Automatic cleaning station
- Manual cleaning

Definition of:

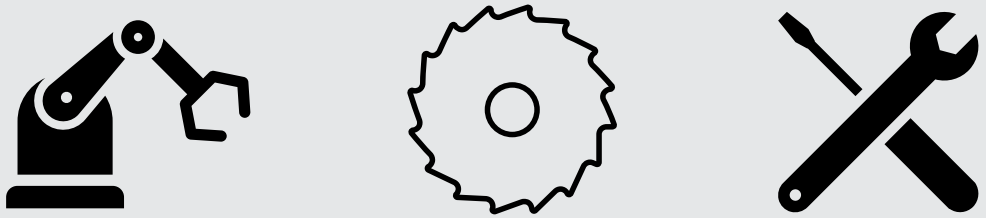
- Logistics concept
- Packaging concept
- Personnel concept
- Room concept

CONCEPT OF A CLEAN PRODUCTION

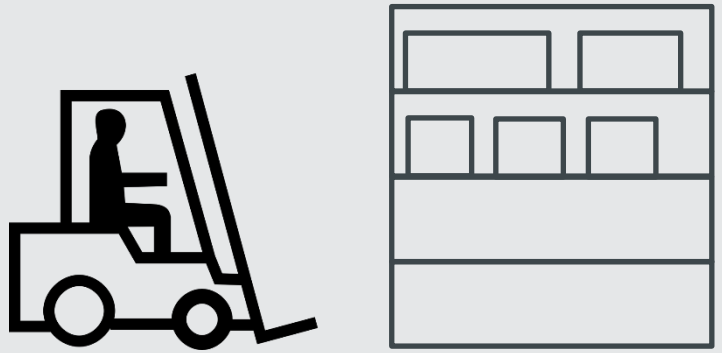
Environment

CleanControlling®

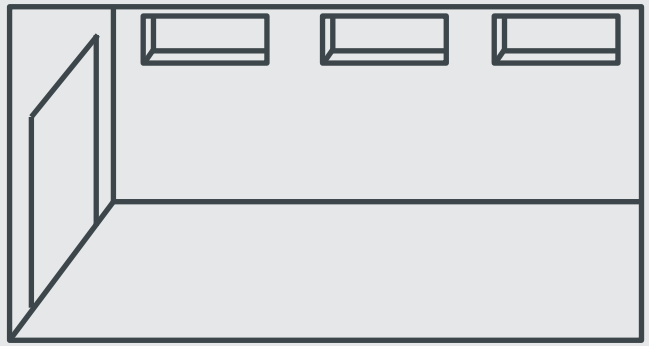
Processes / Production equipment



Logistics



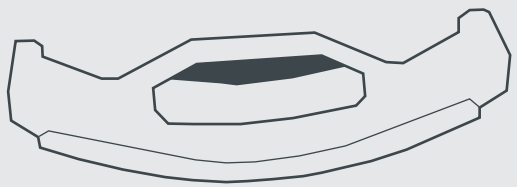
Production environment

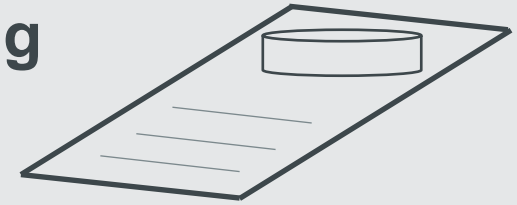


Personnel



Particle monitoring





DESIGN OF THE ASSEMBLY ENVIRONMENT

Cleanliness areas according to VDA19.2

Cleanliness grade 0

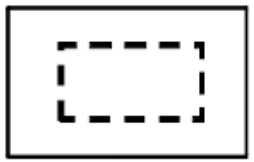
- Uncontrolled zone



- No separate areas
- No cleanliness-orientated regulation (other than 5S)

Cleanliness grade 1

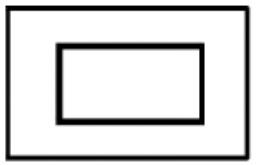
- Cleanliness zone



- Separation
- Cleanliness-orientated regulation
- No special clean air technology

Cleanliness grade 2

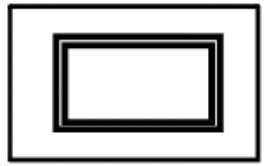
- Cleanliness room



- Fixed constructional separation from other zones
- Cleanliness-orientated regulation
- No special clean air technology

Cleanliness grade 3

- Cleanroom



- Fixed constructional separation from other zones
- Cleanliness-orientated regulation
- Clean Air Technology
- "Room in room system" with airlocks

Source: VDA 19.2

DESIGN OF THE ASSEMBLY ENVIRONMENT

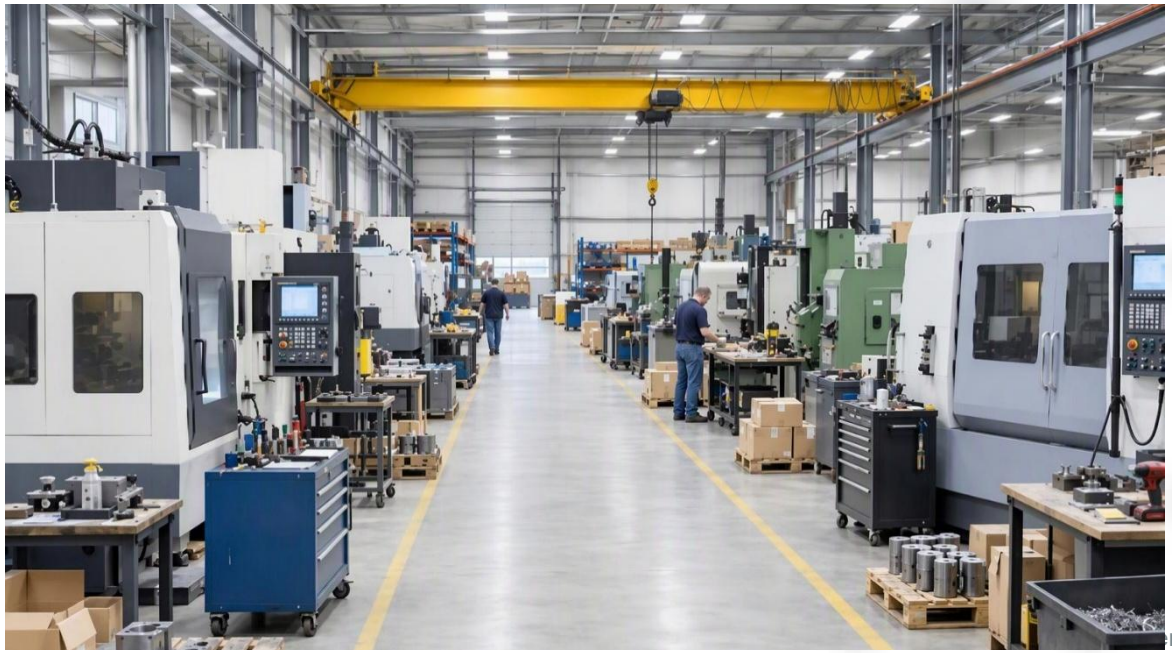
Cleanliness areas according to VDA19.2

CleanControlling®

Cleanliness grade 0

- Uncontrolled zone





DESIGN OF THE ASSEMBLY ENVIRONMENT

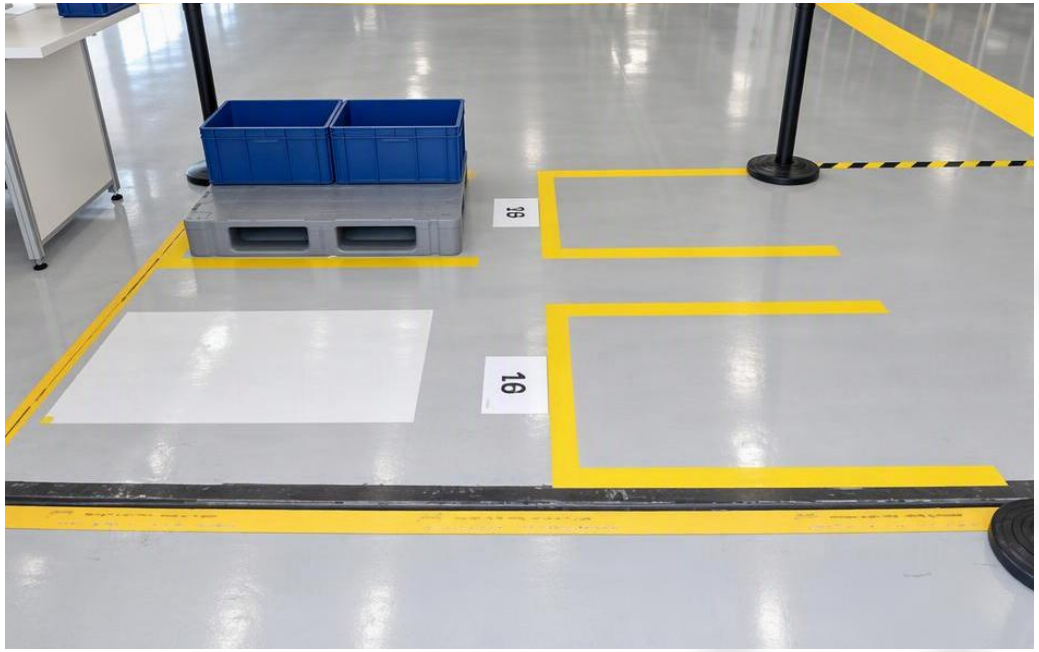
Cleanliness areas according to VDA19.2

Cleanliness grade 1

- Cleanliness zone







Source: CleanControlling

DESIGN OF THE ASSEMBLY ENVIRONMENT

Cleanliness areas according to VDA19.2

Cleanliness grade 2

- Cleanliness room



Source: Tesla Motors, Inc.



Source: Oechsler



Source: Oechsler

DESIGN OF THE ASSEMBLY ENVIRONMENT

Cleanliness areas according to VDA19.2

Cleanliness grade 3

- Cleanroom



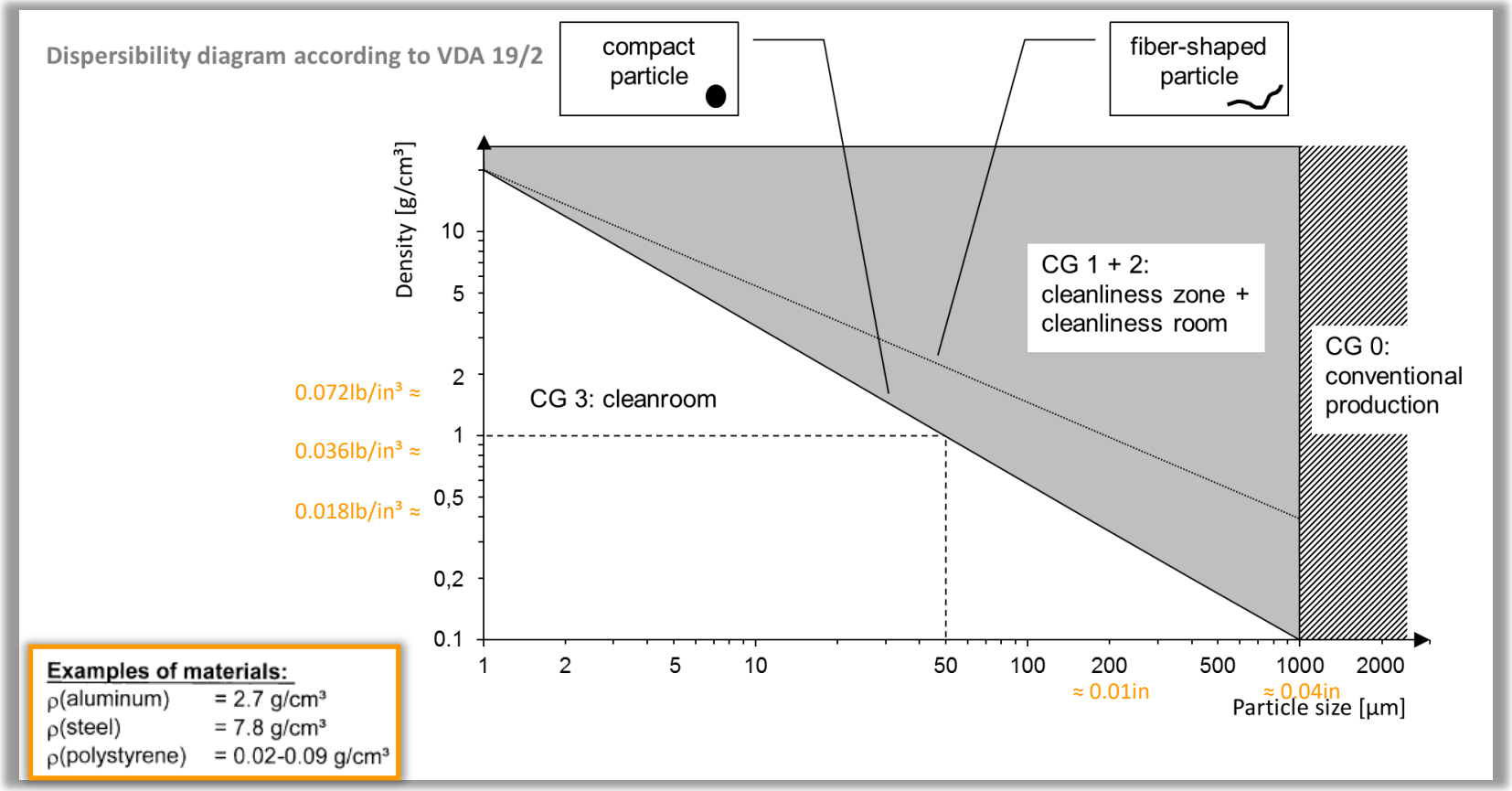




Source: CleanControlling

SELECTION OF THE CLEANLINESS LEVEL

Dispersibility diagram



Reading the diagram

Axes

Particle size [µm] and density [g/cm³]

Two particle types

Compact and fiber-shaped particles each have their own line, separating cleanroom (CG 3) from cleanliness zone / room (CG 1 + 2).

Why do particles of the same size behave so differently? A stone and a feather show it.

Source: based on VDA 19.2

SELECTION OF THE CLEANLINESS LEVEL

Dispersibility diagram



Same height, different fall

Stone

High density, small surface: it falls quickly and settles close to its source.

→ **compact particles**

Feather

Low density, large surface: it sinks slowly and drifts far on the air flow.

→ **fibers**

The longer a particle stays airborne, the further it can spread.

SELECTION OF THE CLEANLINESS LEVEL

Dispersibility diagram



Air flow from the front

Stone

High density, small surface: the air flow hardly changes its path. It lands at the same spot.

→ **compact particles**

Feather

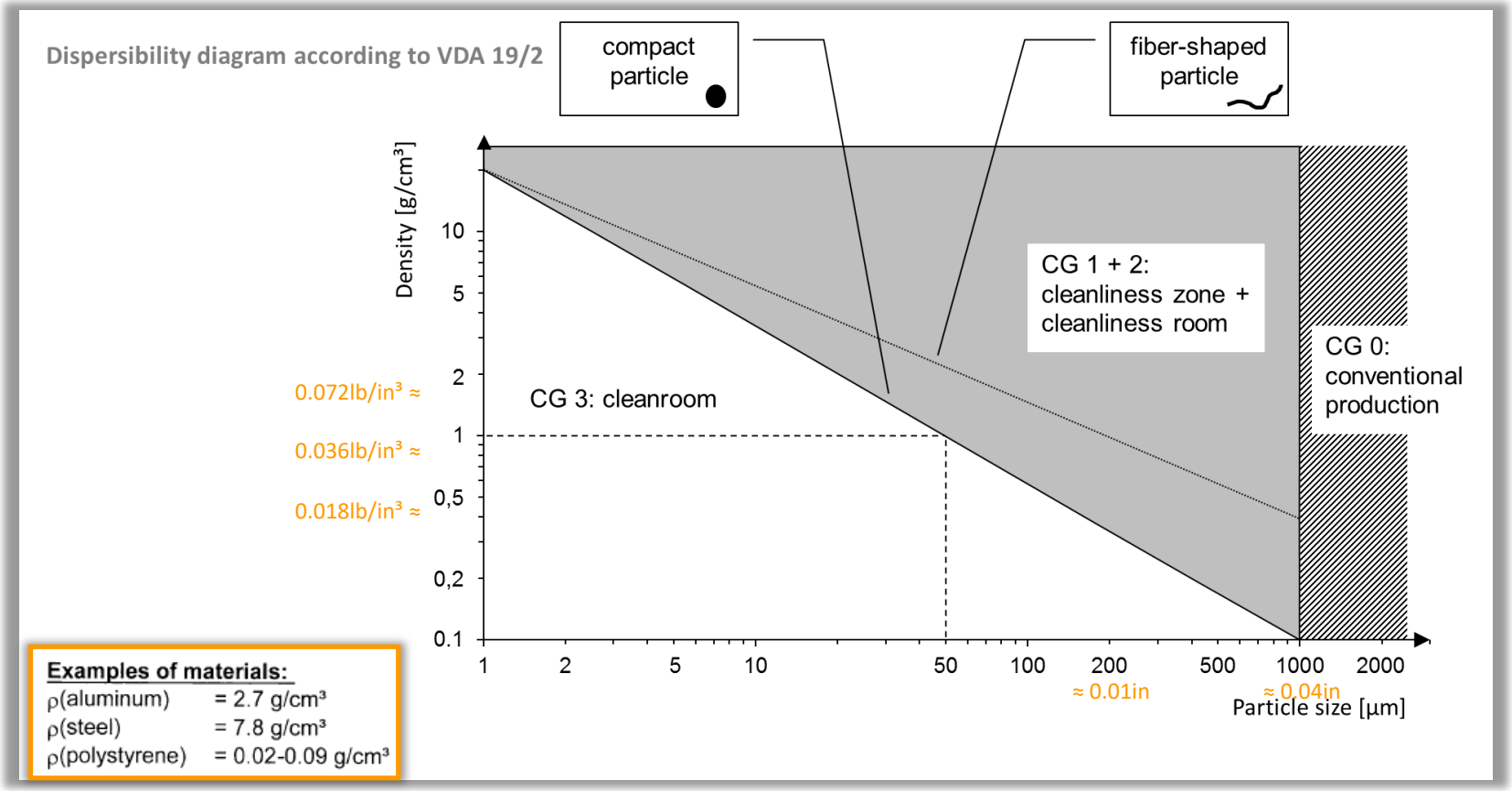
Low density, large surface: the air flow carries it off its path and keeps it airborne.

→ **fibers**

Dispersibility: the lower the density and the larger the surface, the further an air flow carries a particle.

SELECTION OF THE CLEANLINESS LEVEL

Dispersibility diagram



Stone
high density, small surface: falls quickly

Feather
low density, large surface: floats





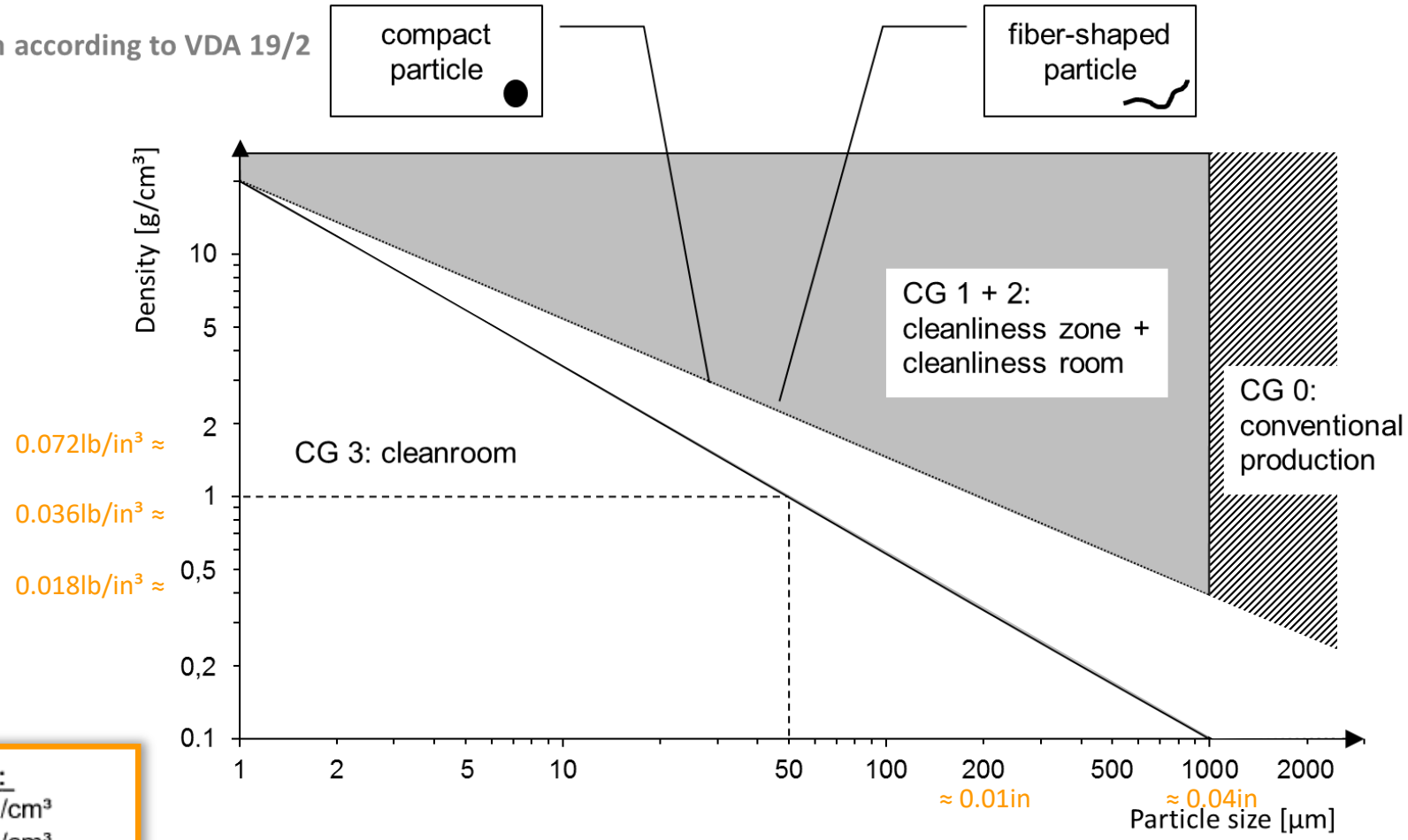
Dispersibility: whether a particle stays airborne or quickly settles to the ground depends on its geometry and density.

Source: based on VDA 19.2

SELECTION OF THE CLEANLINESS LEVEL

Dispersibility diagram

Dispersibility diagram according to VDA 19/2



Examples of materials:

ρ(aluminum)	= 2.7 g/cm³
ρ(steel)	= 7.8 g/cm³
ρ(polystyrene)	= 0.02-0.09 g/cm³

Source: based on VDA 19.2

PLANNING EXAMPLE - SELECTION OF THE CLEANLINESS LEVEL

Cleanliness requirements according to VDA 19.1

Particle size x (regarding the particle length)			**Metallic particles** [Quantity / 1000cm²]	**Non-met. particles** [Quantity / 1000cm²]	**Fibers** [Quantity / 1000cm²]
	x ≤	200 µm	not limited	not limited	not limited
200 µm	< x ≤	400 µm	max. 25 particles		
400 µm	< x ≤	800 µm	0		
	x >	800 µm	0	0	

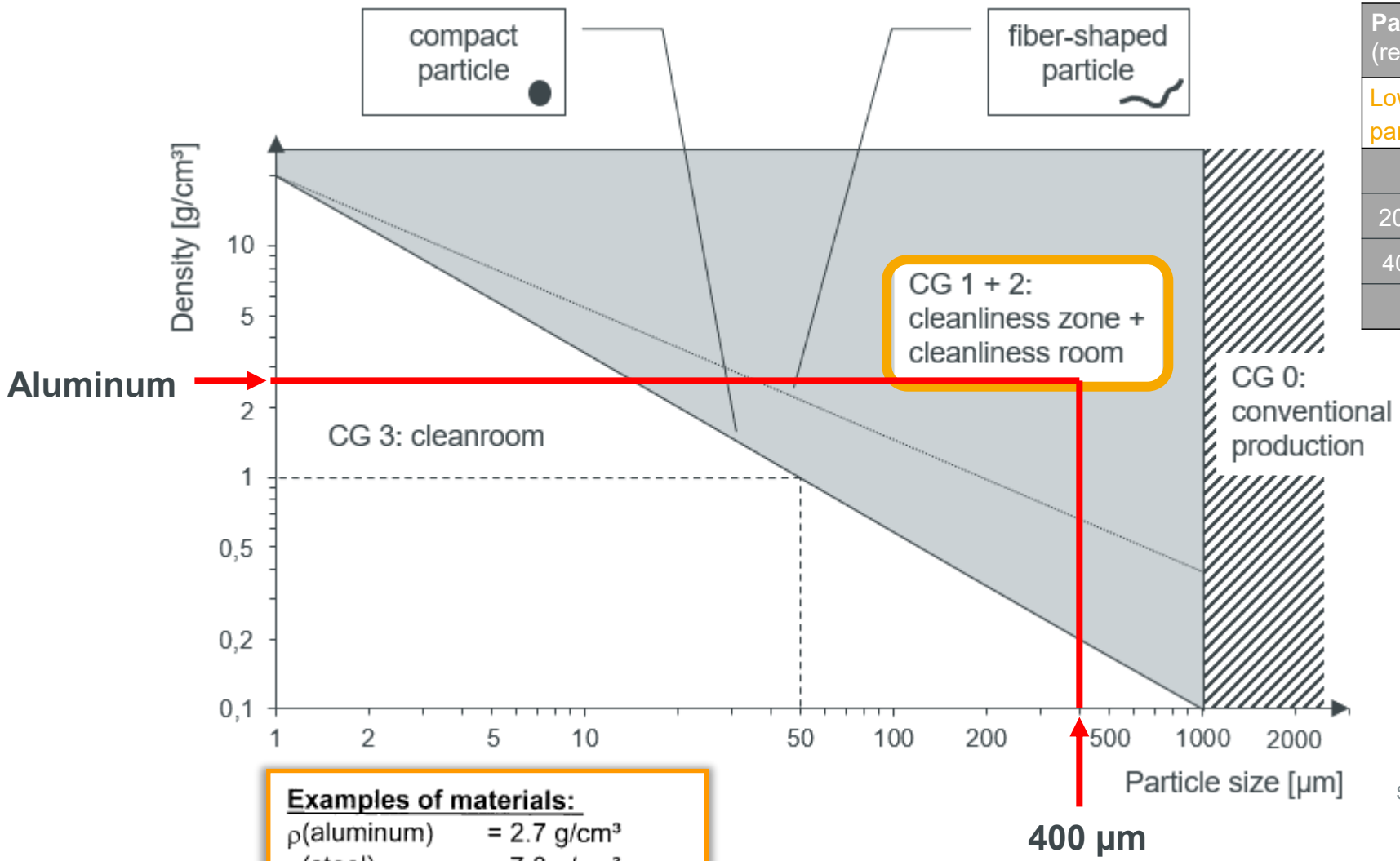
PLANNING EXAMPLE - SELECTION OF THE CLEANLINESS LEVEL

Cleanliness requirements according to VDA 19.1

Particle size x (regarding the particle length)			**Metallic particles** [Quantity / 1000cm²]	**Non-met. particles** [Quantity / 1000cm²]	**Fibers** [Quantity / 1000cm²]
Lowest density of the relevant particle materials			Aluminum 2,7 g/cm³	Wood (Pallet) 0,4 g/cm³	Not-metallic !
	x ≤	200 µm	not limited	not limited	not limited
200 µm	< x ≤	400 µm	max. 25 particles		
400 µm	< x ≤	800 µm	0		
	x >	800 µm	0	0	

PLANNING EXAMPLE - SELECTION OF THE CLEANLINESS LEVEL

Dispersibility diagram

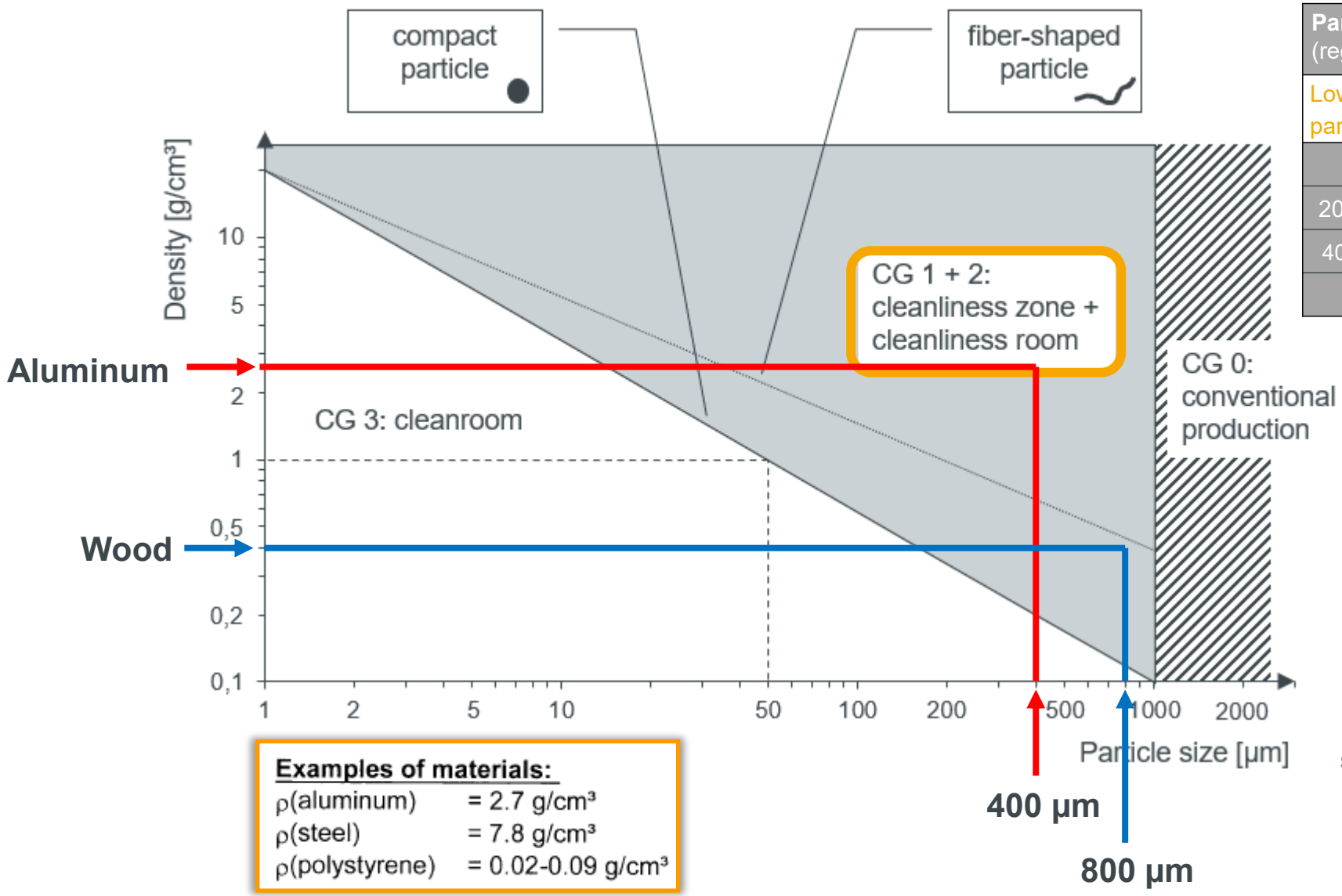


Particle size x (regarding the particle length)			Metallic particles [Quantity / 1000cm²]
Lowest density of the relevant particle materials			Aluminum 2,7 g/cm³
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Source: based on VDA 19.2

PLANNING EXAMPLE - SELECTION OF THE CLEANLINESS LEVEL

Dispersibility diagram



Particle size x (regarding the particle length)			Non-met. particles [Quantity / 1000cm²]
Lowest density of the relevant particle materials			Wood (Pallet) 0,4 g/cm³
	x ≤	200 µm	not limited
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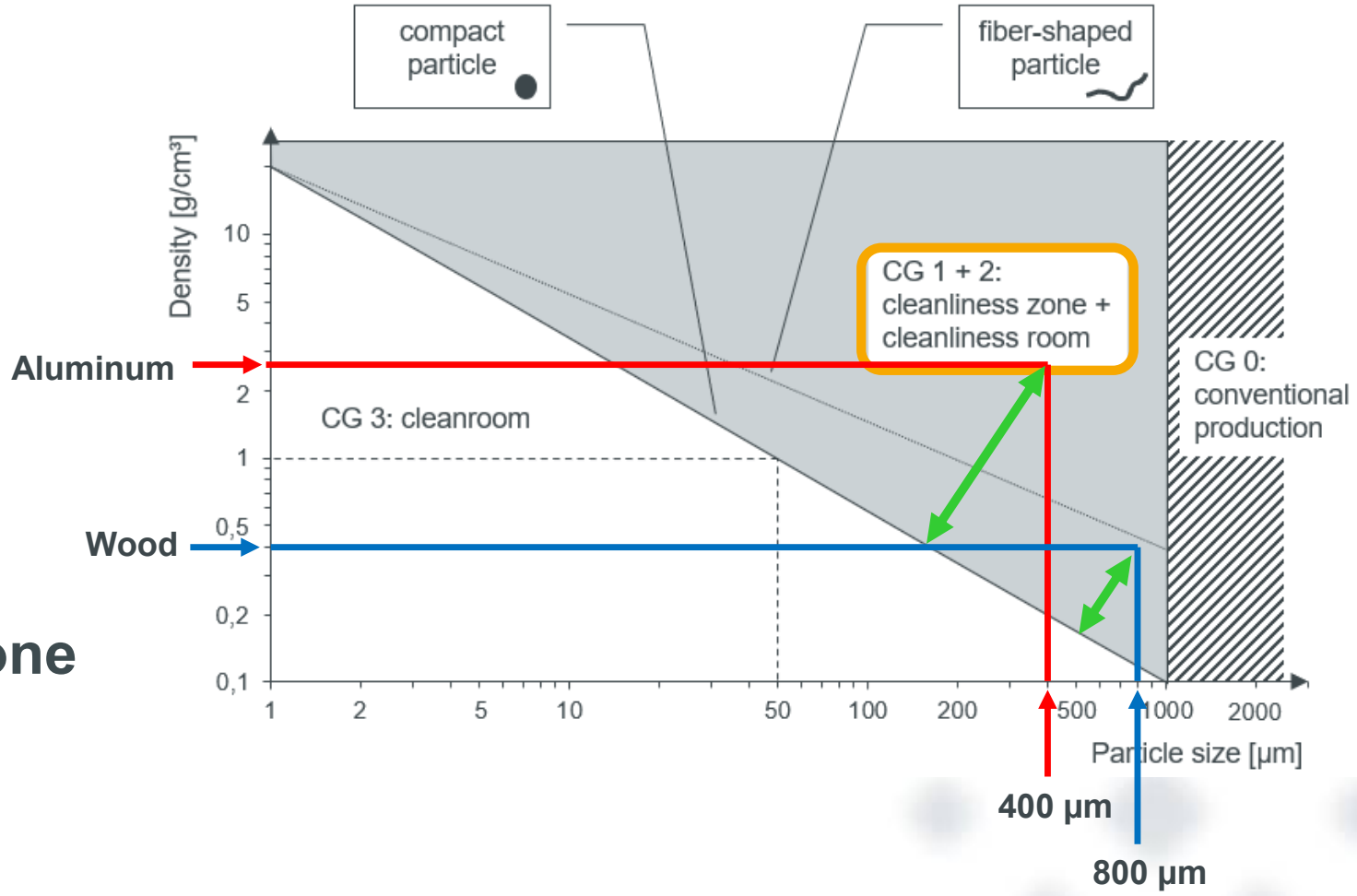
Source: based on VDA 19.2

PLANNING EXAMPLE - SELECTION OF THE CLEANLINESS LEVEL

Dispersibility diagram

- No information about the environmental condition
- Assumption:
  - No air flows through open gates, doors or windows
  - No particle swirling processes in neighboring lines

→ Selection cleanliness zone



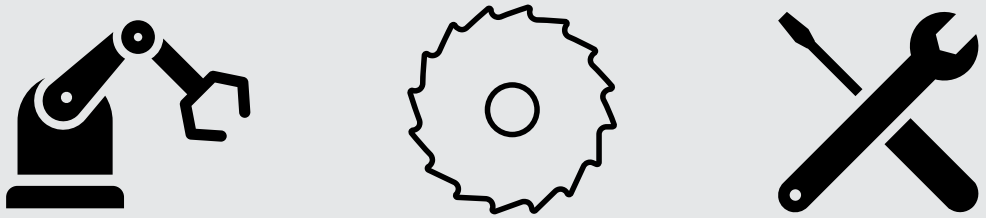
Source: based on VDA 19.2

CONCEPTION OF A CLEAN PRODUCTION

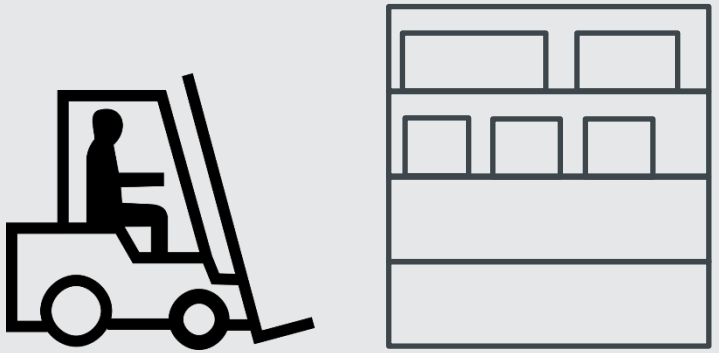
Personnel

CleanControlling®

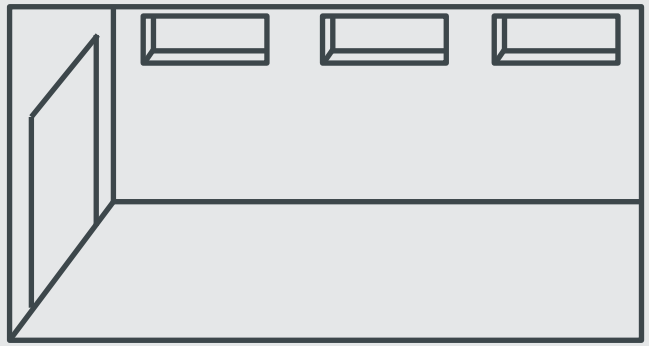
Processes / Production equipment



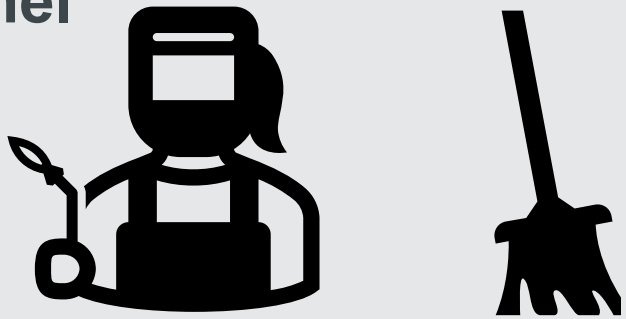
Logistics



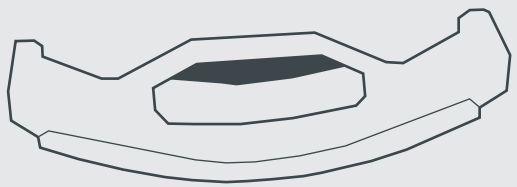
Production environment

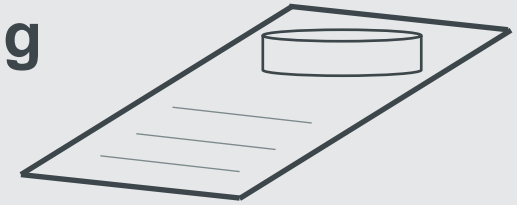


Personnel



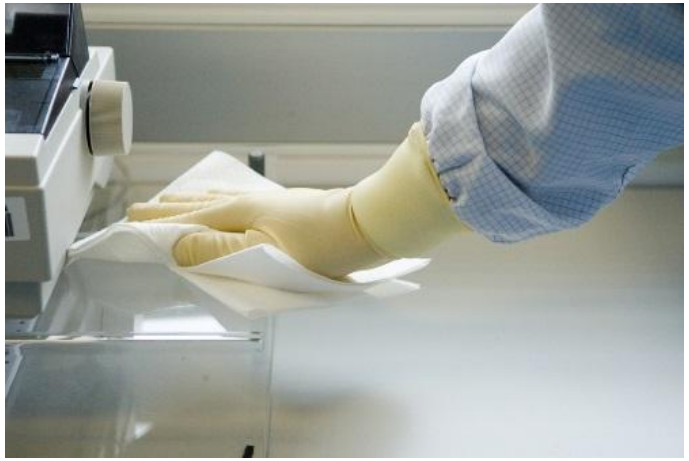
Particle monitoring

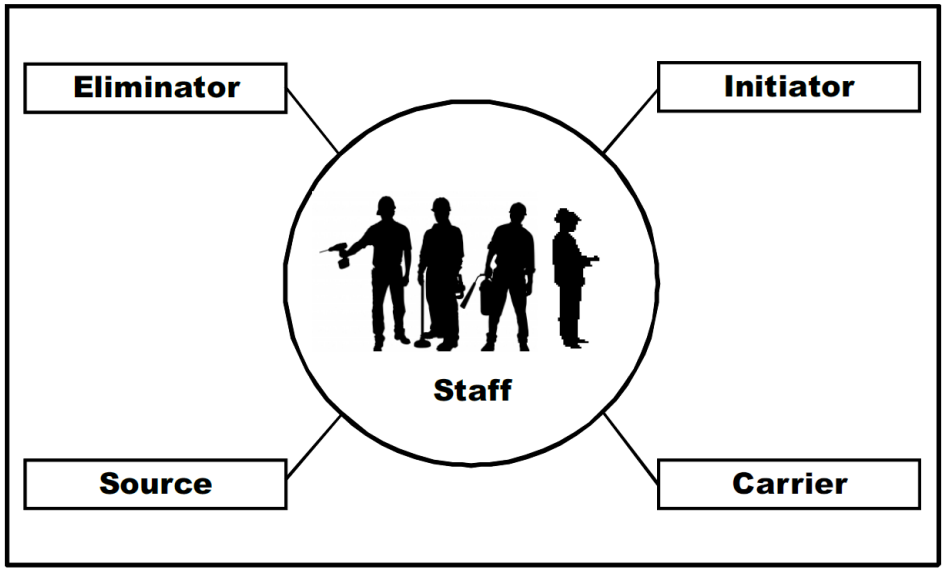




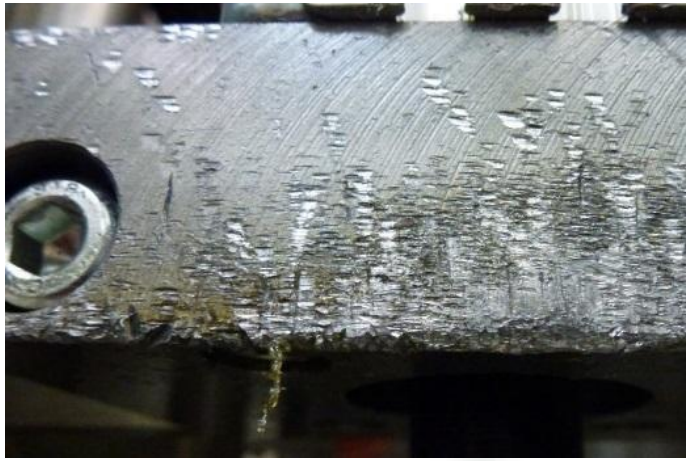
PERSONNEL QUALIFICATION

Influencing factors - personnel





Source: VDA 19.2







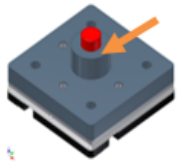
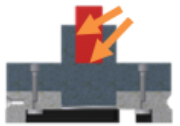
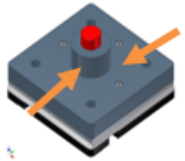
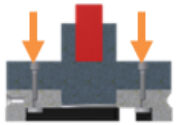
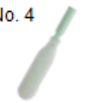
PERSONNEL QUALIFICATION

Source – Initiator – Carrier - Eliminator

- Appropriate cleaning through definition of area-based cleaning schedules
- Reduction of particle carry spreading
- Training and sensitization of personnel

Flächenbezogener Reinigungsplan
Surface-related Cleaning Schedule

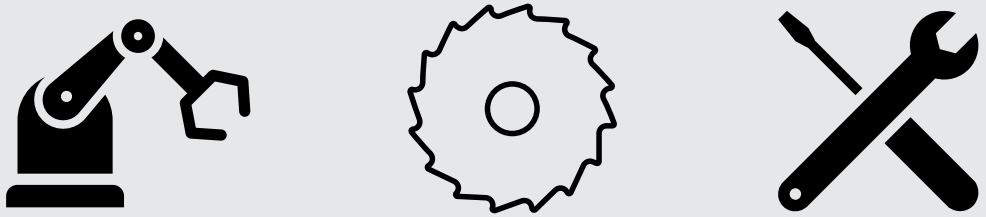
Anlage / Unit: Roundtable xyz
Arbeitsplatz-Nr. / Workplace No.: 1234567
Inventar-Nr. / Inventory No.: 4711

Pos.	Bereich / Objekt Area / Object	Reinigungsmittel Cleaning agent	Detailbeschreibung der Reinigung Detailed description of cleaning	Reinigungsintervall Cleaning Interval		
				Schicht Shift	täglich daily	wöchentlich weekly
1	Cylindrical support 	damp microfibre cloth with GC No. 4	Wipe the cylindrical support.	X		
2	Ground-/wall surface 	cleaning tools 0815 with GC No. 04	1. Clean the interior of the fixture with the cleaning mandrel, moisten the cleaning mandrel and turn it in the fixture. 2. Check that the particles have been removed from the fixture, no more particles shall be visible.	hourly		
3	External area 	suction system damp microfibre cloth with GC No. 4	Vacuum the outer surface of the workpiece carrier and wipe with a damp, fibre-free cloth.	X		
4	All openings 	swab with GC No. 4 	Moisten Swap and clean pin holes and gap around the screws with the swap	X		
	...					

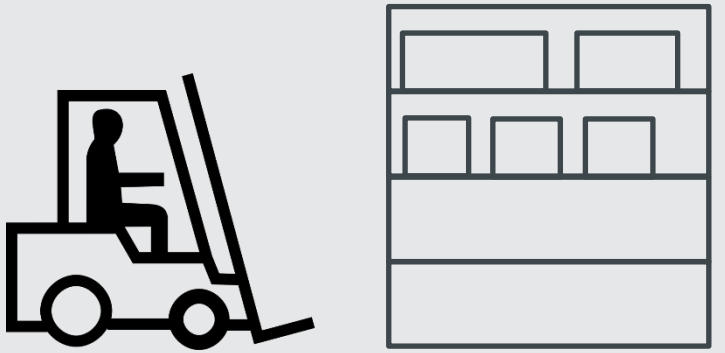
CONCEPTION OF A CLEAN PRODUCTION

Particle monitoring

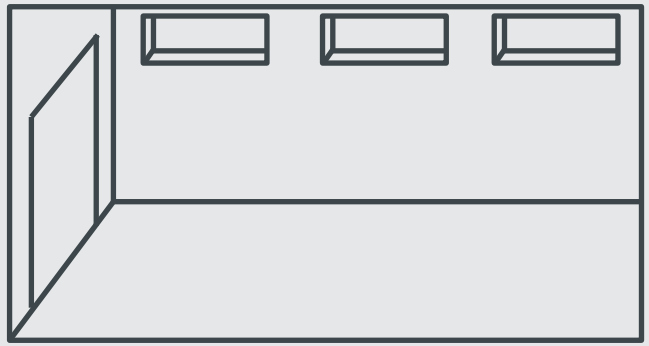
Processes / Production equipment



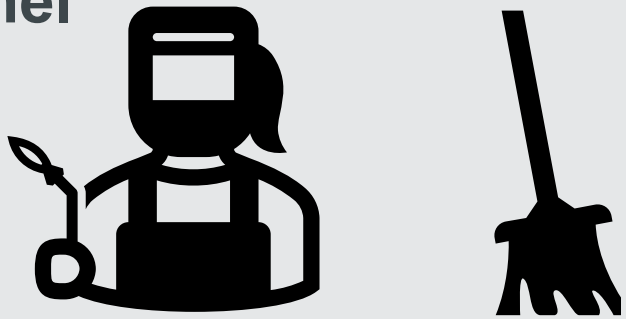
Logistics



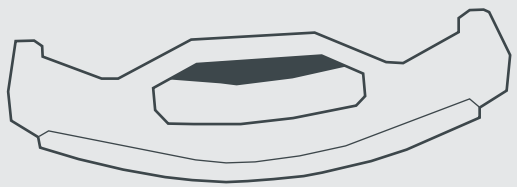
Production environment

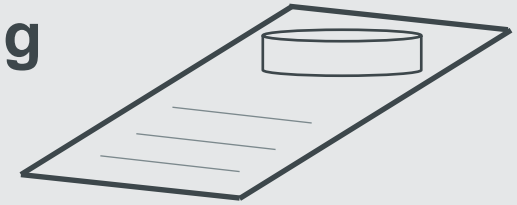


Personnel



Particle monitoring





PARTICLE MONITORING

Products







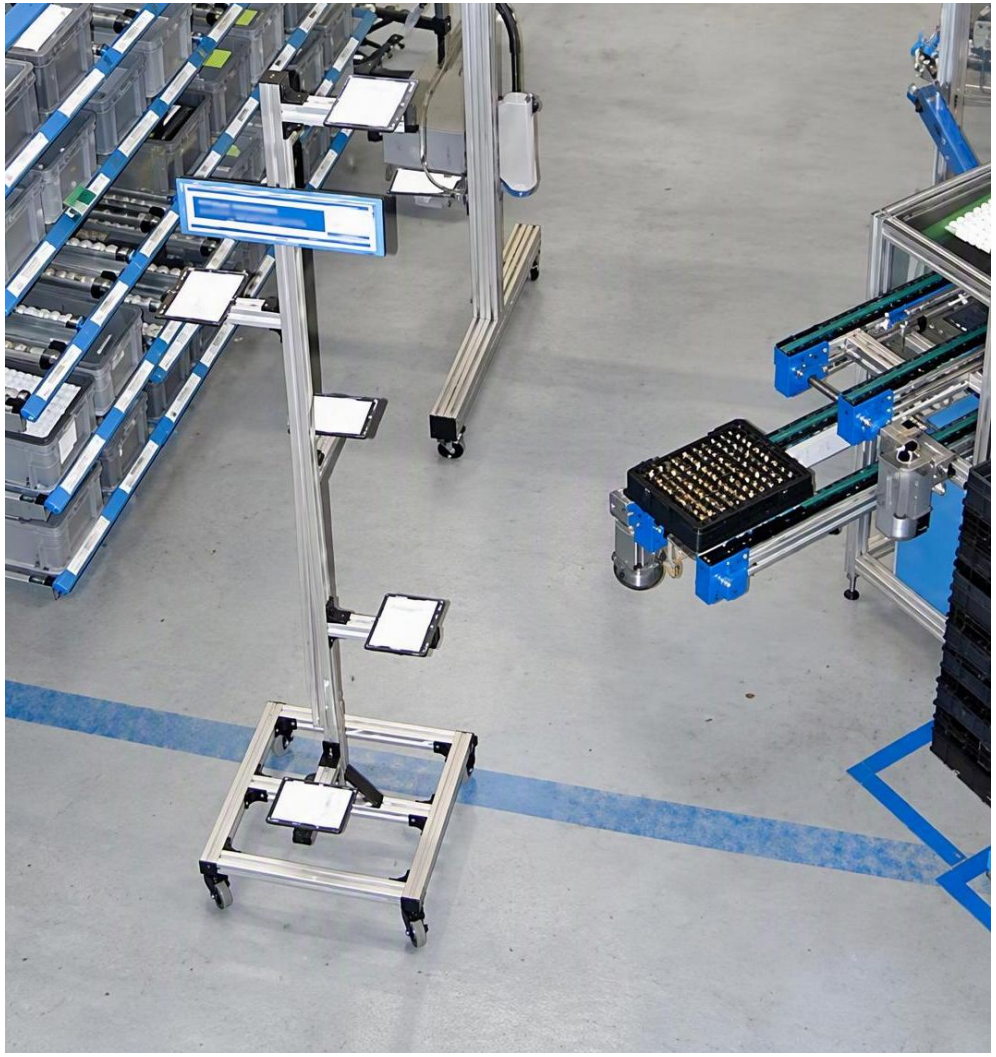




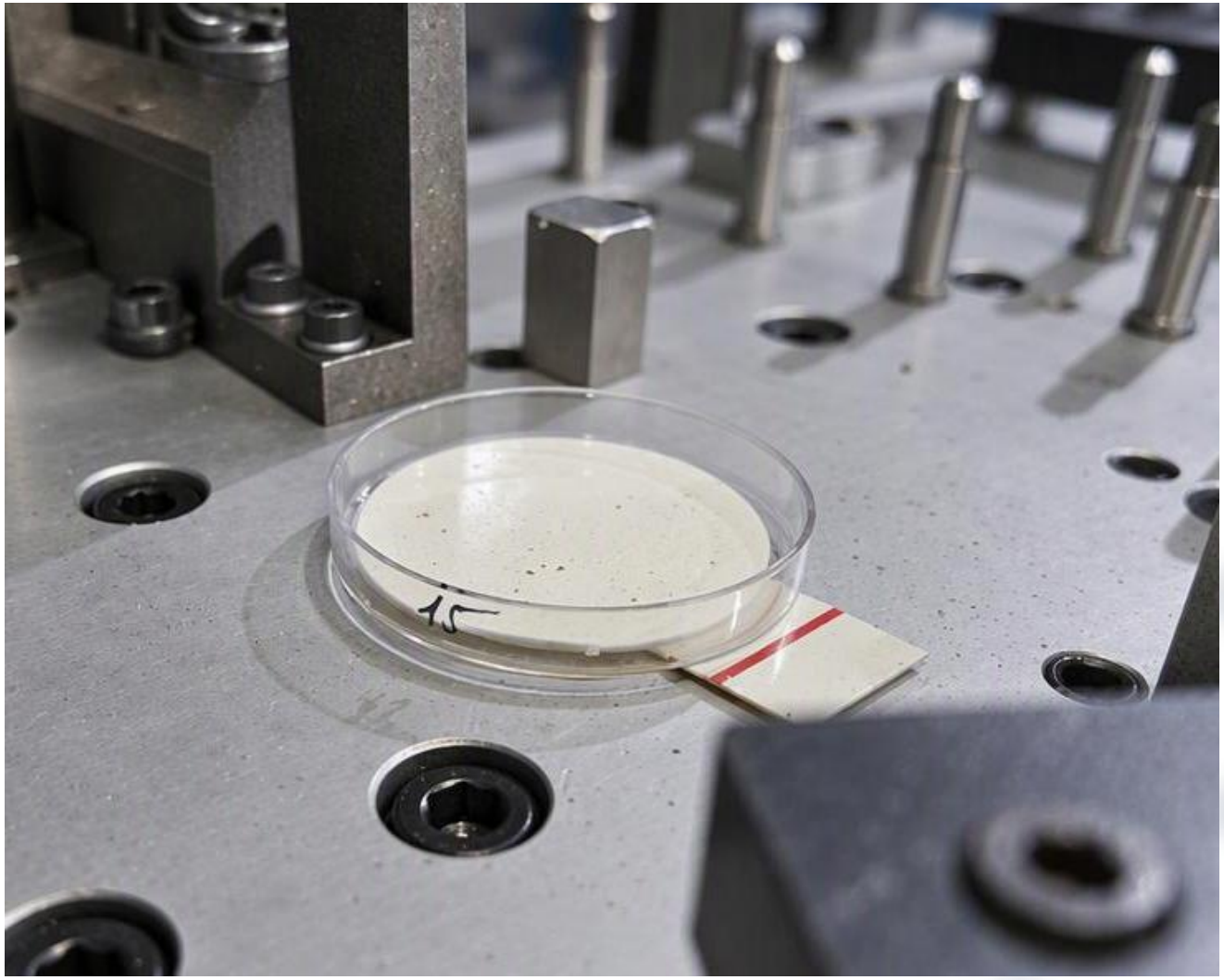
PARTICLE MONITORING

Environmental cleanliness & process cleanliness

Environmental cleanliness



Process cleanliness



PARTICLE MONITORING

Determination of the cleanliness value (Illig value)

Particle size [µm]	Weighting factor
5 ≤ x < 15	0
15 ≤ x < 25	0
25 ≤ x < 50	0
50 ≤ x < 100	1
100 ≤ x < 150	4
150 ≤ x < 200	9
200 ≤ x < 400	16
400 ≤ x < 600	64
600 ≤ x < 1000	144
1000 ≤ x	400



Particle count per particle trap

Normalized to a reference area of 1000cm²

Calculated on an exposure time of 1 hour

Weighted according to particle size

Cleanliness value (Illig value)

PARTICLE MONITORING

Meaning and cleanliness values

Max. permissible particle size = Max. permissible Illig value
(Component specification) (Environmental cleanliness value)

Guideline value to gain a general feel for the required cleanliness

Example:

Max. permissible particle size = **400 µm**

⇨ *max. permissible Illig value of production environment (component) =* ***400 Illig*** *(1/1000cm²h)*

Illig-Value (all particles without fibers) → **T**otal **C**ontamination **V**alue (TCV)

Other cleanliness figures:

For metallic particles (exclusively) → **M**etallic **C**ontamination **V**alue (MCV)

For fibers (exclusively) → **F**ibers **C**ontamination **V**alue (FCV)

(Since only a part of the sedimenting elements is taken into account, there is no 1: 1 correlation to the limit value)

CONCLUSION

- **The processes themselves** represent the greatest influence on product cleanliness
- **The room concept** must be adapted to the requirements ⇨ dispersibility diagram
- **The personnel** must be sensitized
- **Particle monitoring** can be used to verify the suitability of the environment
- **Max. permissible particle size** (component specification) = **max. permissible Illig value** (environment)

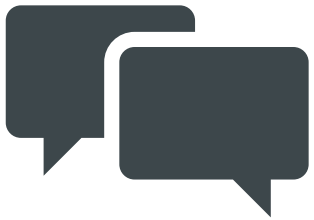
QUESTIONS

CleanControlling®



Do you have any questions?

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Thank you for your attention



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