



Global FCS Supplier Technical Cleanliness Awareness Training

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Global FCS Supplier Technical Cleanliness Overview

The Goal for this session is that you...

- Understand Technical Cleanliness in Manufacturing based on VDA 19 Part 2
- What CG0/CG1/CG2/CG3 cleanliness grades mean
- Review current TI Fluid Systems current customer cleanliness requirements
- TI Fluid Systems supplier cleanliness expectations moving forward, internal cleanliness versus external cleanliness

Global FCS Technical Cleanliness in Manufacturing Overview

What Effects/Influences Technical Cleanliness in Manufacturing?



PROCESS

ENVIRONMENT

MATERIALS

PEOPLE



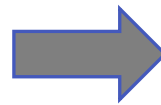
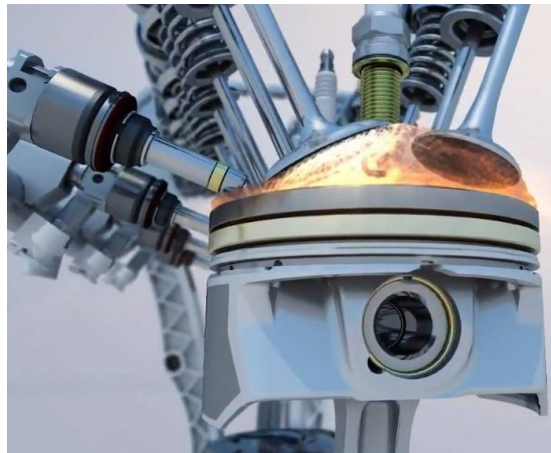
Technical Cleanliness in Manufacturing (in the beginning)

Evolving Vehicle Technology started driving product cleanliness few years ago

Cleanliness requirements then extended to other Gas and Diesel applications as system efficiency & accuracy improved to meet **performance** expectations and emissions regulations...

Federal Government designated a stall as a safety event

GDI – Ultra lean burnand the effects of injector contamination



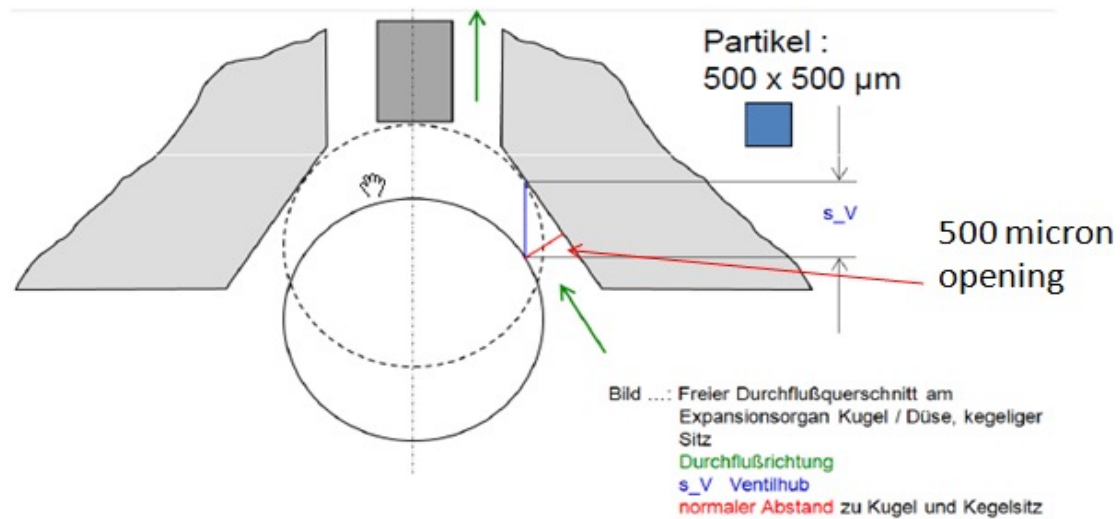
Technical Cleanliness in Manufacturing

Thermal Products-WHY??

Sketch of the TXV



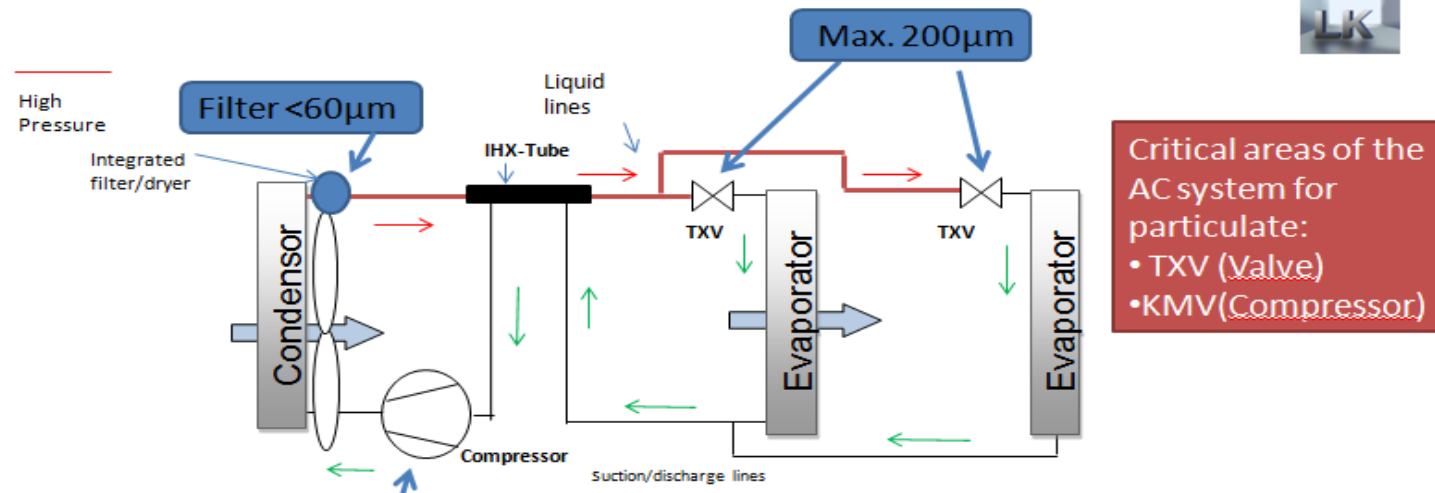
- Normal Abstand: 1 ton Ventil: 0,262 mm



Technical Cleanliness in Manufacturing

Thermal Products-WHY??

REQUIREMENT OF THE MAX. PARTICLE SIZE AND HARDNESS



Max 500*500*1000

Max. Requirements for the particle size is on the liquid line to filter / dry

No particles harder than HV 400 allowed

KKL	Maximum Particle sizes
Compressor	500 μm *500 μm *1000 μm MAX
A/C Lines(liquid/suction/discharge)	Solid particles 200 μm MAX
condensor	Flitter 10 μm *500 μm Max
TXV (expansion valve)	Non-Metallic Particles 50 μm *1000 μm MAX
Evaporator	

Seite 2



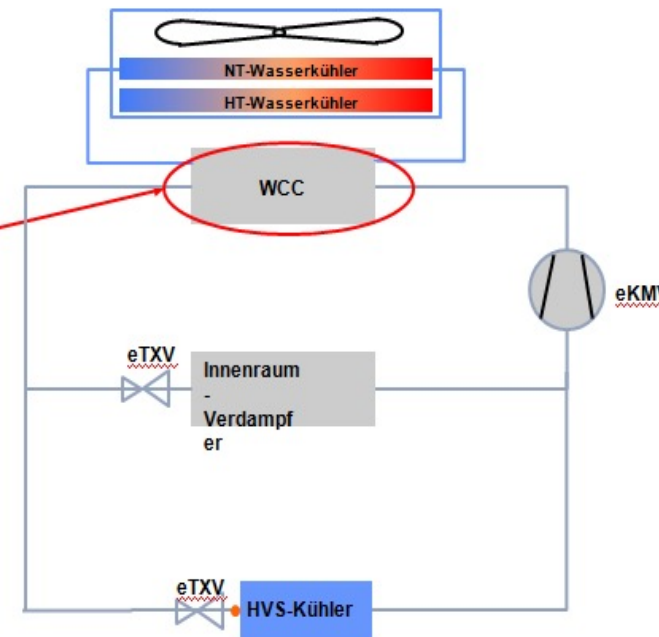
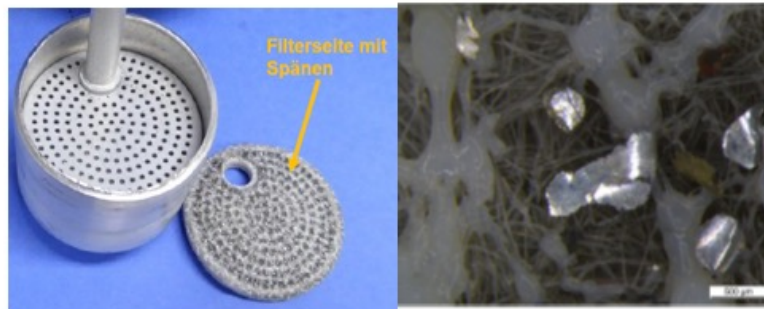
Technical Cleanliness in Manufacturing

Actual Customer Warranty Claim

INNERE REINHEIT KÄLTEKREISLAUF PHEV-SYSTEME FREMDPARTIKEL WCC/KONDENSATOR

Umfang EI-42
Umfang EA (EA-3 / EA-4)

Filter-/Trocknerflasche WCC Beispiel G38 PHEV
(Analyse Werk 1)



Technical Cleanliness in Manufacturing

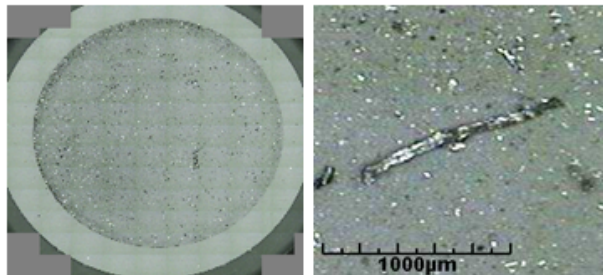
Actual Customer Warranty

INNERE REINHEIT KÄLTEKREISLAUF PHEV-SYSTEME FREMDPARTIKEL KÄLTEMITTELEITUNGEN

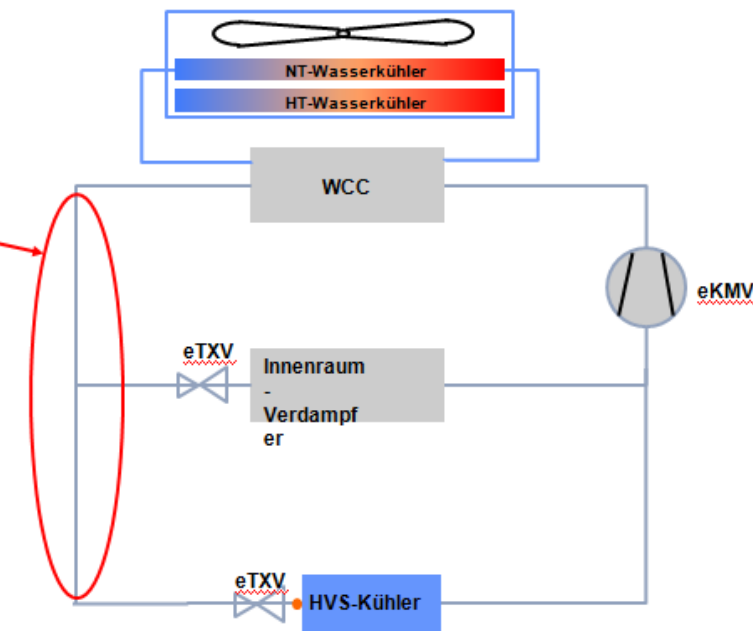
Umfang EI-42
Umfang EA (EA-3 / EA-4)

Kältemittelleitungen Beispiel F15 (Analyse Werk 10)

Metallischer Partikel



AC 64005 Specification				
	Size		Specification	Meas. Result
Metallic particles	> 200 µm	(per filter)	0	87
Non-metallic particles ¹	> 500 µm	(per filter)	0	10
Fibres	> 1000 µm	(per filter)	0	0
Weight [mg/dm ³]		(per filter)	< 2.7 mg/dm ³	



Technical Cleanliness in Manufacturing

Summary:

Clogged TXV can lead to compressor damage or failure which drives a warranty charge of **250 to 500 euros** per vehicle. This can occur suddenly or overtime.

Clogged TXV can cost up to 300 euros due to labor.(Warranty)

Hard particles (braze residue and steel from fixturing cause most compressor damage.
(„compressor killers“)



Cleanliness Grades – What are they?



Cleanliness Grades Explained

Technical Cleanliness Definition:

“minimizing contamination in the production environment so that particulates will not constrain or interfere with the subsequent function of the technical component”

- A cleanliness zone is an work area where entry of contamination is prevented to the levels required by the product being manufactured
- Any contamination generated inside the zone is confined and removed in a controlled fashion, sweeping or blowing is not considered a “controlled method”
- In general, contamination should not be generated in a CG2 cleanliness area. All “dirty” process ideally should be in the CG0 and CG1 zones.
- The goal is to achieve “Technical Cleanliness in Assembly”

Cleanliness Grades Explained

CG0 Area (Conventional production zone)

- No additional cleanliness controls outside of normal 6S
- Machining, end forming, wood pallets, cardboard is present
- No special cleanliness training is deployed
- Open windows/doors are permissible
- Contaminate levels of more than 1000 microns are highly likely and contaminate control will be unstable

CG1-Cleanliness Zone

- Separated by special floor markings, partitions and/or ceiling curtains
- Special cleanliness regulations and training required to work in the area
- Some regulations on packaging and its cleanliness level and personnel movement
- Incoming packaging from the outside world should not be allowed into this area
- Cardboard and wood must be limited to begin the contaminate reduction expectation
- A/C is shared with CG0 areas. Open doors/windows limited in CG1
- Contaminate particles in CG1 Zone of 400-1000 microns would be expected but may not be consistent

Cleanliness Grades Explained

CG2-Cleanliness Room

- Separated from CG0/CG1 areas by fixed construction walls and ceilings
- Separate A/C controls with positive pressure and enhanced lighting. No open Windows/Doors
- Can be designed to the size necessary for the production required
- Strict protocols and training to work in the area including special clothing, shoe covers/head covers, etc.
- Special locks and change areas to allow for controlled entry and exit by only those authorized employees
- No card board or wood allowed!
- All packaging must be performed in a special area outside the CG2 cleanliness area
- Defined visitor protocols and controlled entry
- Carts/tables dedicated to the CG2 cleanliness area and are never removed
- No blowing or sweeping is ever allowed in this area
- The environment is regularly sampled utilizing traps to check the presence of airborne particulates
- Contaminate levels in the properly set-up CG2 Cleanliness room will be at the 200-400 micron levels consistently with a potential for even lower levels with tightly controlled protocols and discipline

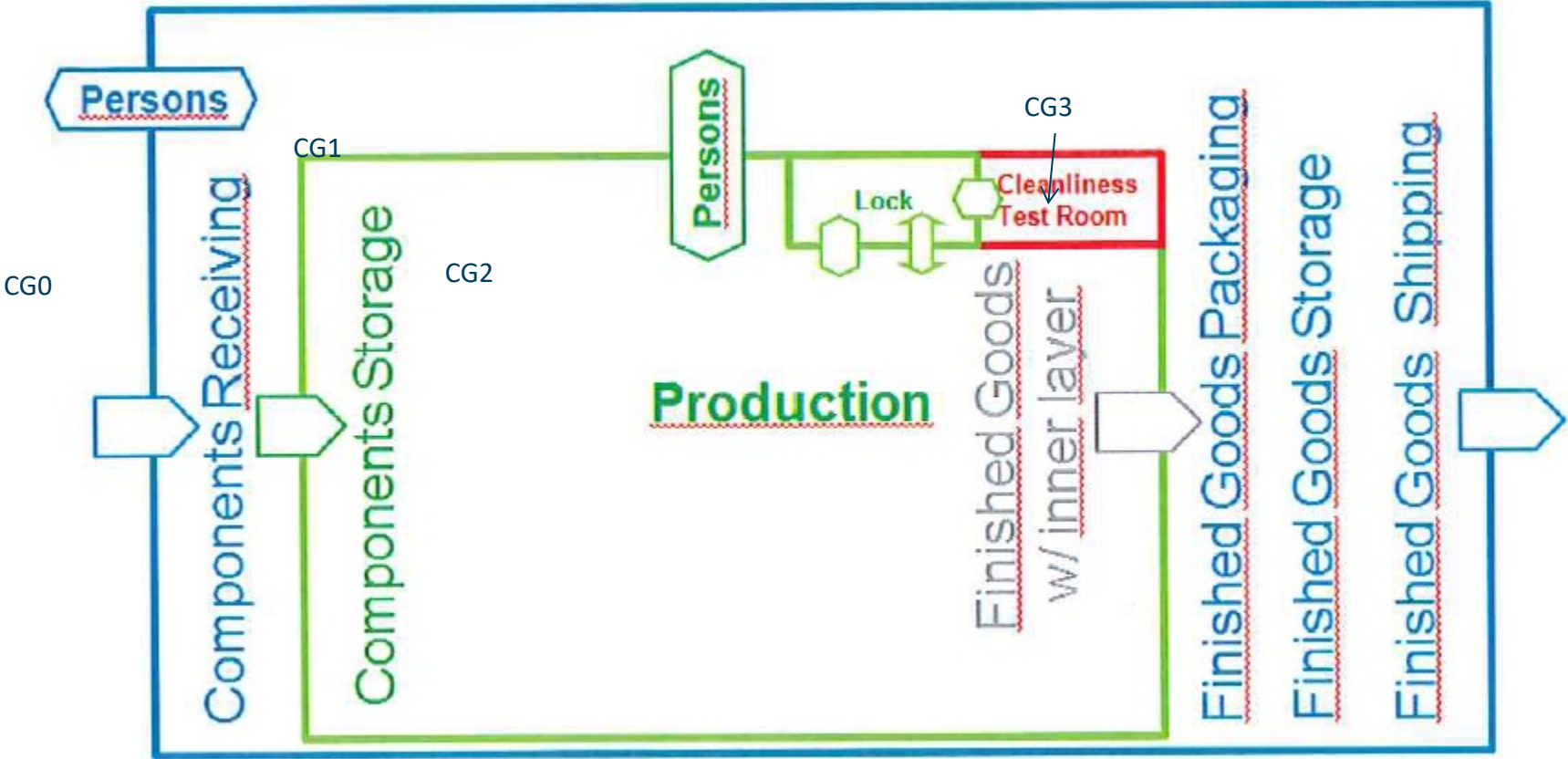
Cleanliness Grades Explained

CG3-Cleanliness Test Room or clean room

- Separated from CG2 areas by fixed construction walls and ceilings
- Separate A/C controls with even more positive pressure and enhanced lighting
- Special clothing including sleeves
- Clean air technology (HEPA 13 or higher)
- Very strict controls and protocols. Very limited entry
- Contaminate levels of 100 microns can be expected

Cleanliness Grades Explained

Typical CG1/CG2/CG3 layout





Customer Requirements and Cleanliness Measurement



Current customer cleanliness requirements(Thermal)

Current Customer Cleanliness Requirements		
Customer	Max. Particle Size Allowed	Particles Allowed
* BMW (a/c) Daimler (a/c)	Before May 2018, zero 200µ Metallic particles (after May 2018, zero particles @200µ maximum for liquid lines and up to 20 particles between 200µ and 400µ) for suction/discharge lines. Zero Flitter > 500µ.	0 particles >200µ metallic and 1000µ fiber (after May 2018 0>200µ (liquid lines) and 20 particles max 200µ-400µ)
Audi / VW (a/c) FCA (a/c)	200µ metallic and 500µ Flitter 200µ metallic/non-metallic max + 2 particles 200-400µ.	0 particles >200µ/500µ. 0 particles >200 except 2 between 200-400µ.
Ford (a/c)	700µ Max 700µ max for discharge/suction lines, 500µ max for liquid lines. 70µ max for sealing surfaces such	0 particles > 700µ 0 particles > 700µ/ 0 particles >500µ/ 0 particles > 70µ (seal surfaces)
GM (a/c)	300µ max metallic(after February 2016) 200µ Max before February 2016	0 particles > 300µ/200µ as applicable
VW/Audi (coolant)	600µ max.	0 particles >600µ 0 particles (fibers) >1000µ. 200-400 150 particles, 400- 600 5 particles, 600-1000 2 particles, 1000-2000 0
Daimler (coolant)	Residual contamination per component (SNR) L<2000 microns	particles no fibers greater than 3000 microns
Bosch (a/c)	600µ max.	0 particles >600µ 8 particles 400-600 and 32

Global FCS(Thermal) Cleanliness Requirements

Valve Bodies-Metal/machined or stamped and Aluminum blocks(internal cleanliness focused)

- 1) **Global TI FCS cleanliness requirements apply.** Metallic and nonmetallic particulate < **500** microns and must be measured by the supplier in an on-going basis and forms a part of the PPAP package and on-going controls (**must be included in the PCP**). This means the supplier must have a controlled cleanliness protocol in place for regular production that is validated at the time of PPAP. This will require the supplier to have a cleanliness process and must be measured for compliance per VDA 19/ISO16232.
- 1) If external component, some leeway can be given but must be agreed upon at sourcing.
- 2) If the part is a sealing component, then **zero particulate** of any size is allowed on that surface. **Sealing surfaces must be protected by packaging.**
- 3) Tumbling media is not allowed in the same room as the product if used for any reason by the supplier. The hardness of this media, if used, must be <400HV with clear protocols in place to avoid contamination of the finished part.
- 4) Final Packaging must be designed to ensure that the above cleanliness requirements are met with special attention to sealing components. At a minimum must be in sealed plastic bags and cardboard cartons should be avoided
- 5) Annual PPAP required to prove on-going capability of the process including cleanliness. (please discussed with SQA if any questions)



Global FCS Supplier Technical Cleanliness Overview & Path Forward

TI Fluid Systems Supplier Technical Cleanliness Expectations

- Technical cleanliness starts at the supply base and is a key component of the overall cleanliness level seen at our FG level
- Expectation that the supplier becomes familiar with VDA 19 part 2 and begins to follow the standard.
- Expectations that the supplier develops a continuous improvement plan to limit the generation and /or the removal of metallic and non-metallic particulate >500 microns. (can be smaller depending on the end customer)
- TIFS expectations are that the supplier develops a measurement system to understand their cleanliness performance on an on-going basis, all part of a robust VDA 19 part II process.
- Internal cleanliness versus external cleanliness explained



Questions?