



# North America Thermal Products Supplier Technical Cleanliness Awareness Training

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# NA Thermal Products Supplier Technical Cleanliness Overview & Path Forward

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## 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

# NA Thermal Products Technical Cleanliness in Manufacturing Overview

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**What Effects/Influences Technical Cleanliness in Manufacturing?**



PROCESS  
ENVIRONMENT  
MATERIALS  
PEOPLE

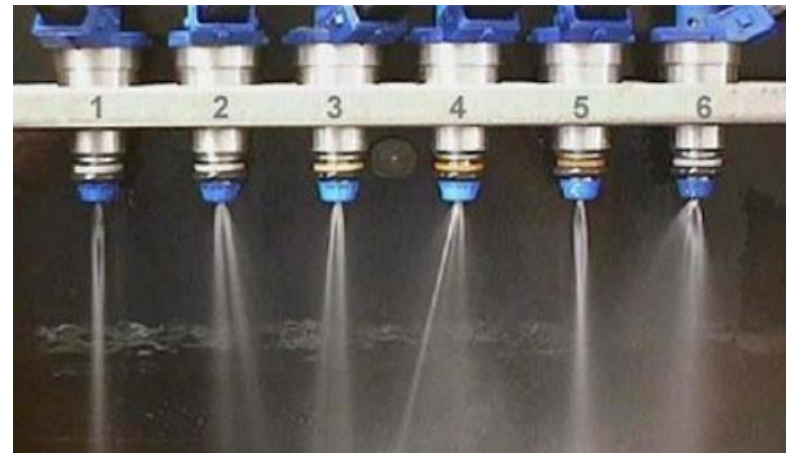
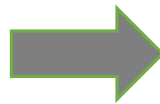
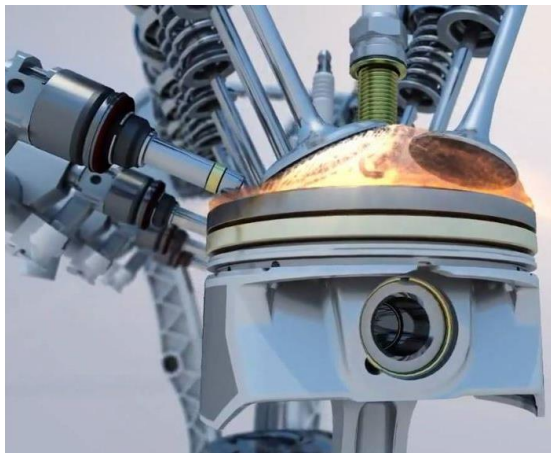
# Technical Cleanliness in Manufacturing (in the beginning)

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 burn .....and the effects of injector contamination



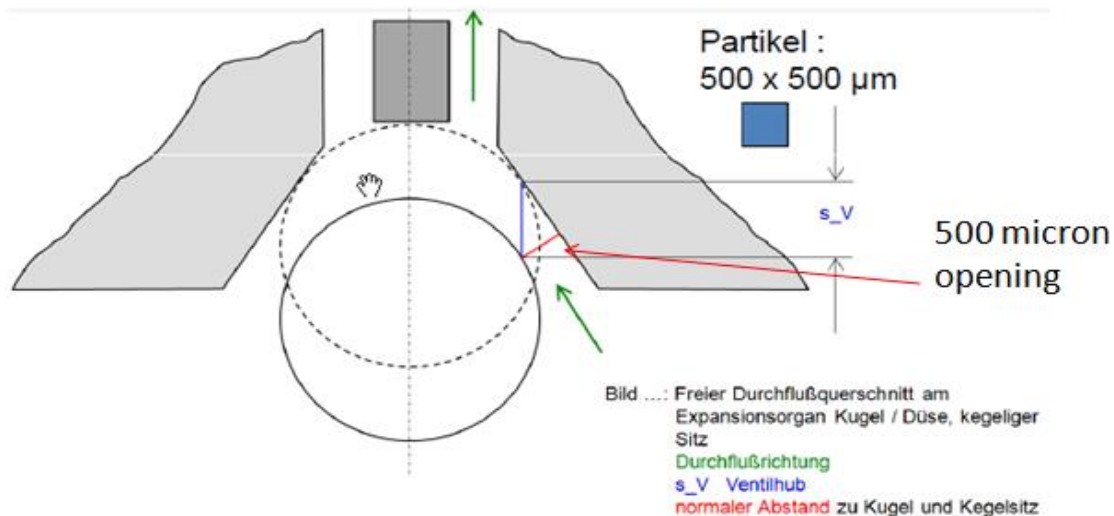
# Technical Cleanliness in Manufacturing

## Thermal Products-WHY??

### Sketch of the TXV



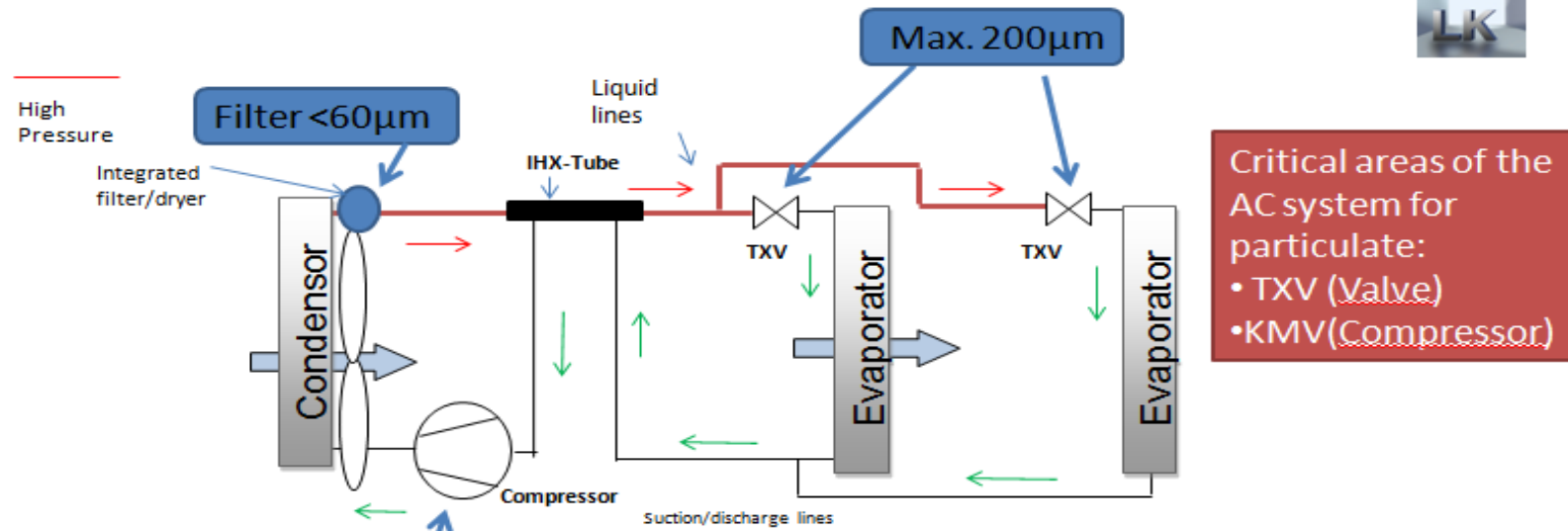
- Normal Abstand: 1 ton Ventil: 0,262 mm



# Technical Cleanliness in Manufacturing

## Thermal Products-WHY??

### REQUIREMENT OF THE MAX. PARTICLE SIZE AND HARDNESS



Max. 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	500µm*500µm*1000 µm MAX
A/C Lines(liquid/suction/discharge)	Solid particles 200 µmMAX Flitter 10µm*500µmMax
condensor	
TXV ( expansion valve)	Non-Metallic Particles 50µm*1000µm MAX
Evaporator	

Seite 2

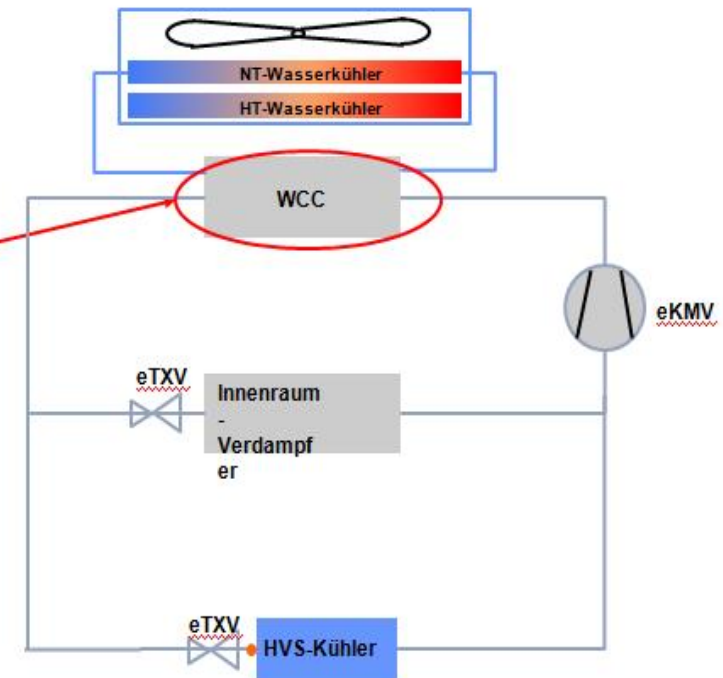
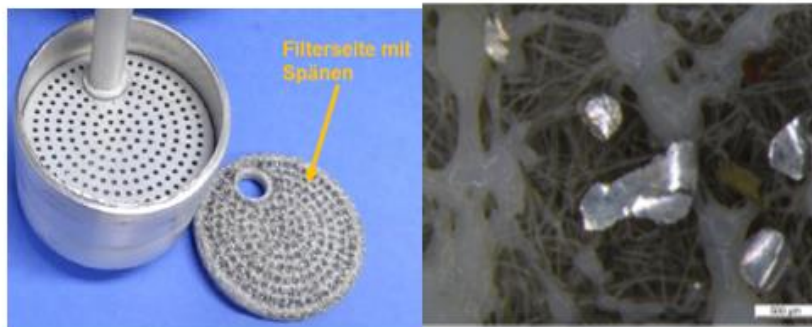
# Technical Cleanliness in Manufacturing

Actual Customer Warranty

## 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

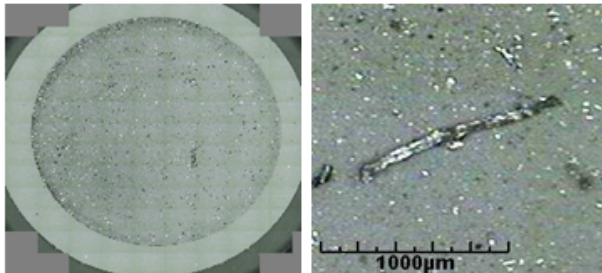
## Actual Customer Warranty

### INNERE REINHEIT KÄLTEKREISLAUF PHEV-SYSTEME FREMPARTIKEL KÄLTEMITTELEITUNGEN

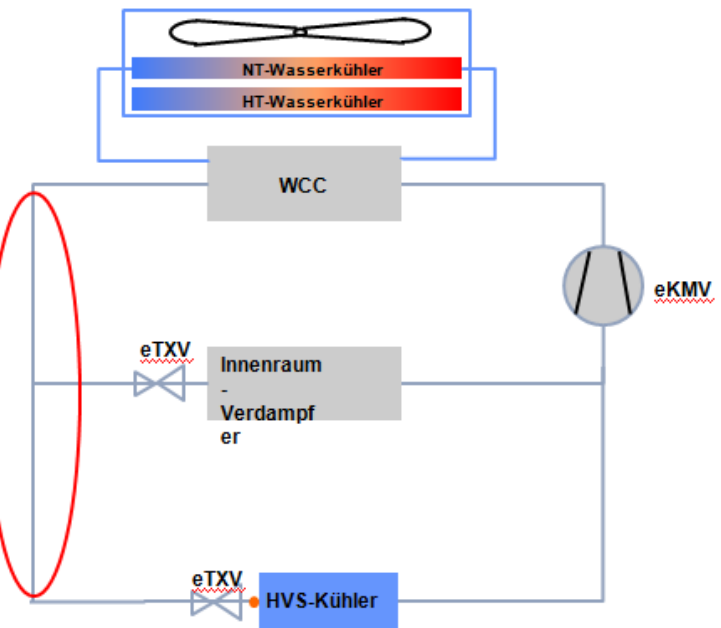
Umfang EI-42  
Umfang EA (EA-3 / EA-4)

#### 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 <sup>1</sup>	> 500 µm	(per filter)	0	10
Fibres	> 1000 µm	(per filter)	0	0
Weight [mg/dm <sup>3</sup> ]		(per filter)	< 2.7 mg/dm <sup>3</sup>	





# Technical Cleanliness in Manufacturing


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## 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

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## **Technical Cleanliness Definition:**

“minimizing contamination so that particulate 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 as 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

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## 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

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## 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

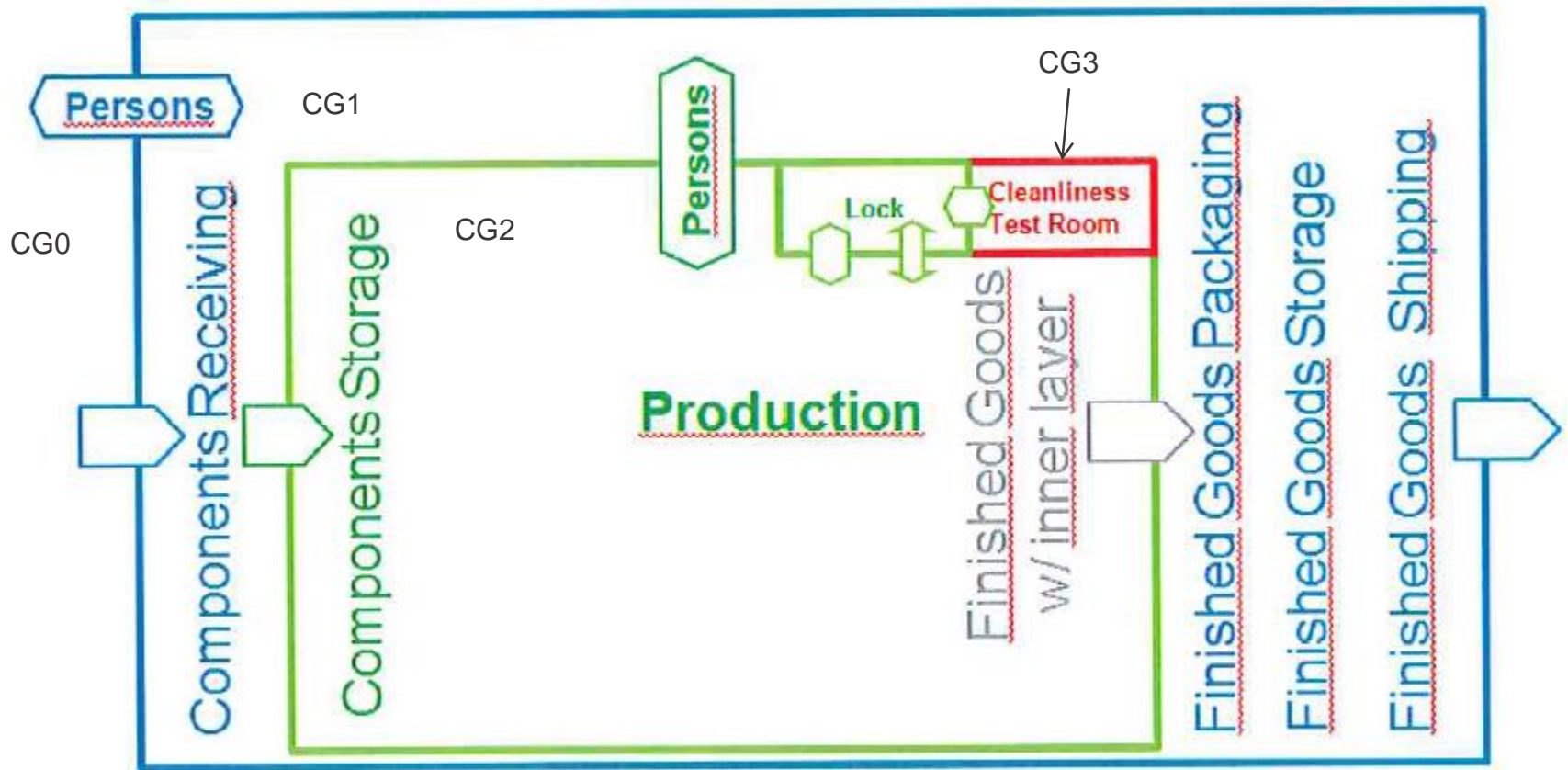
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## CG3-Cleanliness Test Room or clean room

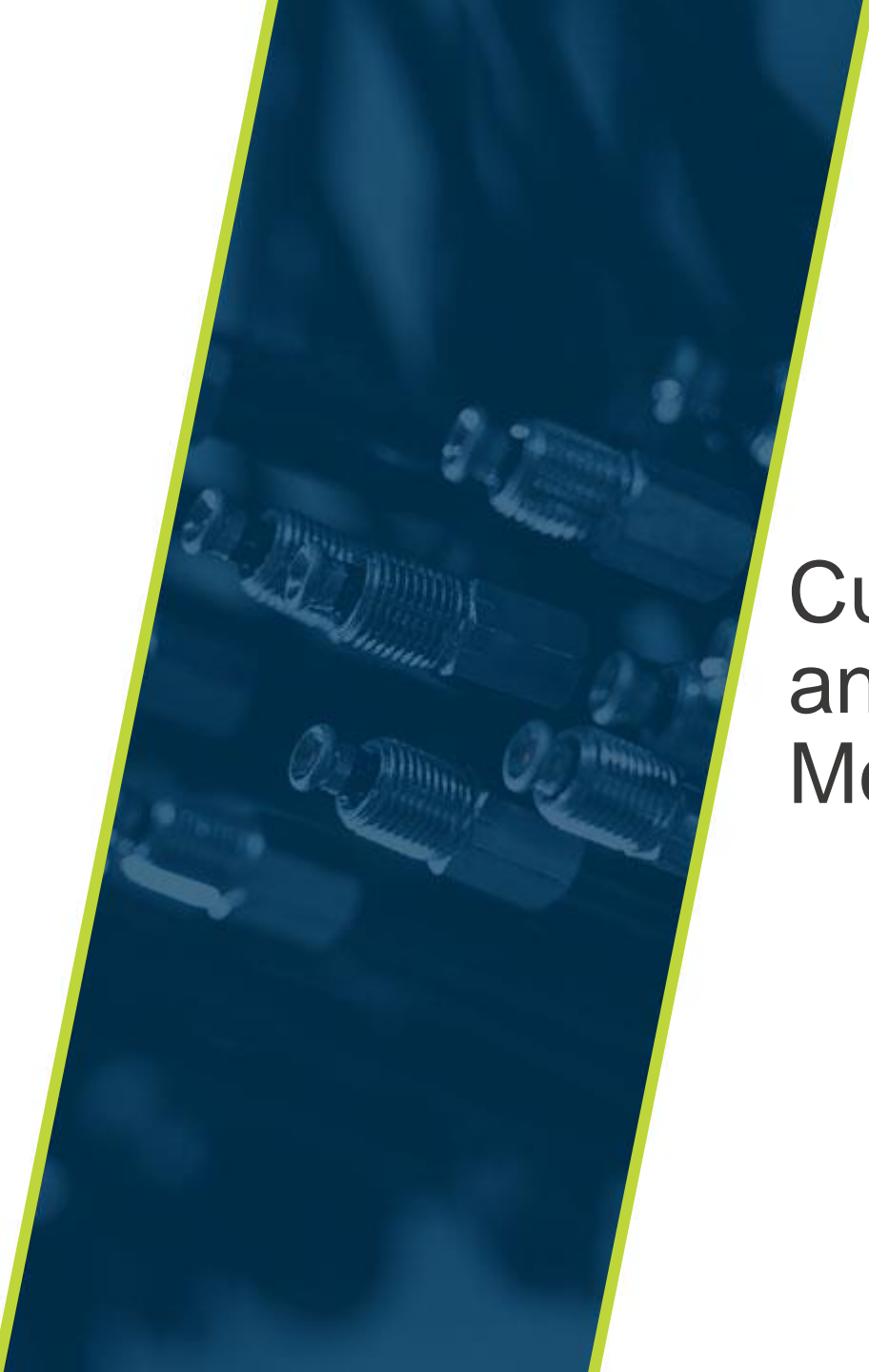
- Separated from CG2 areas by fixed construction walls and ceilings
- Separate A/C controls with even more positive pressure and enhanced lighting
- Special clothing including sleeves
- Clean air technology (HEPA 13 or higher)
- Very strict controls and protocols. Very limited entry
- Contaminate levels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

# Cleanliness Grades Explained

Typical CG1/CG2/CG3 layout







# Customer Requirements and Cleanliness Measurement

# Current customer cleanliness requirements

Current Customer Cleanliness Requirements		
Customer	Max. Particle Size Allowed	Particles Allowed
* BMW (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)
Daimler (a/c)	200µ metallic and 500µ Flitter	0 particles >200µ/500µ
Audi / VW (a/c)	200µ metallic/non-metallic max + 2 particles 200-400µ	0 particles >200 except 2 between 200-400µ
FCA (a/c)	700µ Max	0 particles > 700µ
Ford (a/c)	<b>700µ</b> max for discharge/suction lines, <b>500µ</b> max for liquid lines. <b>70µ</b> max for sealing surfaces such	0 particles > 700µ/ 0 particles >500µ/ <b>0 particles &gt; 70µ (seal surfaces)</b>
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
Daimler (coolant)	Residual contamination per component (SNR) L<2000 micons	200-400 150 particles, 400-600 5 particles, 600-1000 2 particles, 1000-2000 0 particles no fibers greater than 3000 microns
Bosch (a/c)	600µ max.	0 particles >600µ 8 particles 400-600 and 32

# NA Thermal Products QUALITY Requirements

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## Valve Bodies-Metal/machined or stamped and Aluminum blocks

- 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 controlled process and must be measured for compliance per VDA 19/ISO16232. As a guide, the supplier can utilize VDA19 part 2 or other specification for their protocols.
- 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 must be avoided
- 5) Annual PPAP required to prove on-going capability of the process including cleanliness. (please discussed with SQA if any questions)
- 6) Material certification must be less than 1 year old.

# NA Thermal Products Supplier Technical Cleanliness Overview & Path Forward

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## 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)
- Expectations that the supplier develops a measurement system to understand their cleanliness performance on an on-going basis, all part of a robust continuous improvement process

Questions?

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