Understanding the Component Cleanliness Code or CCC of VDA 19 & ISO 16232

CCC = A(B-E17/F-G14/H-I4/J-K2/L-N00) is listed on the print as the required cleanliness – so what does that mean? A little research leads to the discovery that this is a Component Cleanliness Code (CCC) based on VDA 19.1 or ISO 16232 and the cleanliness limits are based upon particle count rather than mass (weight) of contamination.

So how do you decipher that VDA 19 or ISO 16232 Component Cleanliness Code (CCC)?

In front of the parentheses there could be an A, V, or N. "A" = Area = Standard Area = 1,000cm^2 while "V" = Standard Volume of 100cm^3 and "N" = numbers of particles per part. Reported to A or V a numerical Cleanliness Level or Contamination Level or Particle Concentration code is used. Reported to N the actual number of particles per part is listed after the size class letter rather than the Cleanliness Level code.

"B-E" means that size classes B (5µm-15µm), C (15µm-25µm), D (25µm-50µm), and E (50µm-100µm) are combined so that particles from 5µm-100µm make up a combined size class named "B-E." The hyphen (dash) makes it a combined size class.

"17" = Cleanliness Level or Contamination Level = numerical code that allows you to determine number of particles allowed for the size class preceding the Cleanliness Level number. A Cleanliness Level of "17" on an Area based report means there are 64,000 – 130,000 particles in that size class (or combined size class) in the Standard Area of 1,000cm^2. If a Cleanliness Level of "17" is displayed as your Standard Area based Limit then it means up to 130,000 particles are allowed per 1,000cm^2.

"F-G" means that size classes F (100µm-150µm), and G (150µm-200µm) are combined so that particles from 100µm-200µm make up a combined size class named "F-G" which shares a single limit for that combined size class.

“14” as the Cleanliness Level or Contamination Level for F-G means 8,000-16,000 particles in the 100µm-200µm size range were found (if in report findings) or up to 16,000 particles are allowed per 1,000cm^2 if it is a Standard Area based Limit being displayed (on the print or in a table.)

“H-I” means that size classes H (200µm-400µm), and I (400µm-600µm) are combined so that particles from 200µm-600µm make up a combined size class named “H-I.”

“4” as the Cleanliness Level or Contamination Level for H-I means 8-16 particles in the 200µm-600µm size range were found (if on a report) or up to 16 particles are allowed per 1,000cm^2 if it is a Standard Area based Limit being displayed (on the print or in a table.)

“J-K” means that size classes J (600µm-1,000µm), and K (1,000µm-1,500µm) are combined so that particles from 600µm-1,500µm make up a combined size class named “J-K.” --- Note: In older versions of either VDA 19 or ISO 16232 the Particle Size Classes end at K and in those older versions K covered 1,000µm and greater.

“2” as the Cleanliness Level or Contamination Level for J-K means 2-4 particles in the 600µm-1,500µm size range were found (if in report findings) or up to 4 particles are allowed per 1,000cm^2 if it is a Standard Area based Limit being displayed (on the print or in a table.)

“L-N00” means that the combination of size classes L (1,500µm-2,000µm), and M (2,000µm-3,000µm), and N (3,000µm and greater) either had zero particles (on a report) or are allowed zero particles if being displayed as a Limit on the print or in a table.

As you probably noted from examples in this article making a combined size class is done by inserting a hyphen (dash) between the letters representing the starting and ending points of the size class which shares a combined limit for that entire combined size class. CCC = A(K-N1) allows or reports 2 particles 1,000µm or larger per 1,000cm².

If the same size class letters are placed together without a hyphen (dash) like this CCC = A(KLMN1) then each size class so listed either had the same Cleanliness Level of particles found or it gets the Limit that follows - it isn’t a combined size class with a shared limit – rather each size class listed together without hyphenation has simply been assigned the same Contamination Level or Cleanliness Level or Particle

Concentration Class. Based upon normal particle size distribution it would be unusual for smaller size classes to each have the same Limit - but you may see it expressed this way for some or all of the larger size classes when the desire is to give each of the larger size classes the same very small amount of tolerance (ex. KLMN1) which in our standard area based example would mean a Limit of 2 particles per 1,000cm² in each of the listed size classes – so K (1,000µm-1,500µm) would be allowed 2 particles per 1,000cm² and L (1,500µm-2,000µm) would be allowed 2 particles per 1,000cm² and M (2,000µm-3,000µm) would be allowed 2 particles per 1,000cm² and N (3,000µm and greater) would also be allowed 2 particles per 1,000cm². Having or not having a hyphen (dash) makes a BIG difference.

Size classes can be assigned their own Contamination Level which would look like this: CCC = A(B16/C15/D14/E13/F10/G8/H6/I5/J4/K3/L2/M0/N00)

If a size class letter is left out then no limits are being applied to that size class. So if limits are only being applied to particles 50µm and larger then B, C, and D would be left out as in this example CCC = A(E13/F10/G8/H6/I5/J4/K3/L2/M0/N00)

In older versions of either VDA 19 or ISO 16232 the Particle Size Classes end at K and in those older versions K covered 1,000µm and greater. The older Size Class coding will likely remain in use via principles implemented into OEM specs. Be aware.

I hope that helps demystify the Component Cleanliness Code (CCC) for you.

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Please feel free to give us a call – we do a lot of VDA 19 or ISO 16232 based testing for a wide array of customers here at the Crown Cleanliness Testing Laboratory in Jackson, Michigan USA. Give us a call when you have a question about cleanliness testing or need cleanliness testing done. We offer Standard Turnaround for scheduled cyclical testing and Expedited Turnaround when you need results ASAP. We also sell Lab kits and can train your personnel to do cleanliness testing if your customer insists you do the testing in-house.

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As this is written in March 2018 the draft revision of ISO 16232 uses the same Particle Size Classes and Cleanliness Level code as the March 2015 revision of VDA 19.1 The charts in each may differ in manner of display but the Component Cleanliness Code (CCC) is once again uniform between the two standards. –JG-

Tables 9-1 & 9-2 from VDA Band 19-1 EN 201503

Table 9-1: (Particle) size classes

Size class	Size x [µm]
B	5 ≤ x < 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 < 1000
K	1000 ≤ x < 1500
L	1500 ≤ x < 2000
M	2000 ≤ x < 3000
N	3000 ≤ x

Table 9-2: Particle concentration classes

Cleanliness Level	Particle count (per 1000 cm² or pro 100 cm³)	
	including	up to
00	-	0
0	0	1
1	0	2
2	0	4
3	0	8
4	0	16
5	0	32
6	0	64
7	0	130
8	0	250
9	0	500
10	0	1×10^3
11	0	2×10^3
12	0	4×10^3
13	0	8×10^3
14	0	16×10^3
15	0	32×10^3
16	0	64×10^3
17	0	130×10^3
18	0	250×10^3
19	0	500×10^3
20	0	1×10^6
21	0	2×10^6
22	0	4×10^6
23	0	8×10^6
24	0	16×10^6

This is the coding from the 2007 version of ISO 16232 – Size classes ended with K being 1000µm and greater (no L, M, or N) – Contamination Level or Cleanliness Level coding was the same as current revision . For economic reasons you will continue to see this older version used in some OEM specs which implemented its principles prior to the latest revision of ISO 16232 or VDA 19.1. So be aware of which revision of VDA 19.1 or ISO 16232 is cited/referenced in the OEM spec. Also be certain you have the most current revison of the OEM specification – so you are working with the correct limits, etc.. –JG-

Tables 1 & 2 from ISO 16232-10 2007

Table 1 — Size classes for particle counting

Size class	Size X (µm)
B	$5 \leq x < 15$
C	$15 \leq x < 25$
D	$25 \leq x < 50$
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	$1000 \leq x$

NOTE 1 The size of largest particle size (found or allowable) can be expressed individually, independent of the nominal size classes specified above.

NOTE 2 According to individual requirements, size ranges may be combined and left out.

Table 2 — Definition of the contamination level of a component

Number of particles per 1000 cm^2 or per 100 cm^3		Contamination level
More than	Up to and including	
0	0	00
0	1	0
1	2	1
2	4	2
4	8	3
8	16	4
16	32	5
32	64	6
64	130	7
130	250	8
250	500	9
500	1×10^3	10
1×10^3	2×10^3	11
2×10^3	4×10^3	12
4×10^3	8×10^3	13
8×10^3	16×10^3	14
16×10^3	32×10^3	15
32×10^3	64×10^3	16
64×10^3	130×10^3	17
130×10^3	250×10^3	18
250×10^3	500×10^3	19
500×10^3	1×10^6	20
1×10^6	2×10^6	21
2×10^6	4×10^6	22
4×10^6	8×10^6	23
8×10^6	16×10^6	24

NOTE n the test report, the raw number of particles should be noted.