



IFA

Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

Proficiency testing for in-house and external measuring stations - results and evaluation

Proficiency testing scheme

**Volatile organic compounds -VOC- with
thermal desorption 2026, with own
sampling 2**

17 June 2026

Substances / Measurands per Sample:

Two series of test gases with different concentrations containing ten different substances were offered. To exclude possible blank values the base gas of test gas device was tested by sampling.

The test gases contained the following substances:

Measurand	CAS-No.	Purity	Order No.	Manufacturer
Benzene	71-43-2	99.0 %	319953-500ML	Honeywell
1-Butanol	71-36-3	99.9 %	20808.291	VWR
n-Butyl acetate	123-86-4	99.8 %	1.09652.1000	Merck
Cumene (Isopropyl benzene)	98-82-8	for analysis	329735000	Thermo Scientific
n-Decane	124-18-5	94.0 %	8.20383.1000	Merck
Ethyl benzene	100-41-4	99.0 %	03080-250ml	Honeywell
Naphtalene	91-20-3	99.0 %	33347.18	Thermo Scientific
Toluene	108-88-3	for analysis	108325.1000	Merck
1,2,3-Trimethylbenzene	526-73-8	92.4 %	T73202-50ml	SigmaAldrich
p-Xylene	106-42-3	99.0 %	134449-500ml	SigmaAldrich

Sample Carriers:

The participants of this proficiency testing scheme loaded their own sample carriers by using their own equipment.

Evaluation of the PT scheme:

The PT scheme was evaluated according to DIN ISO 5725-2 using the software PROLab Plus. The Z-score of all participating laboratories is calculated with the aid of the outlier-free mean value and the outlier-free standard deviation. A permissible deviation (s) of 10% was set.

The "reference values" given are the mean value from the quality control samples taken at the test gas stream in parallel to the sampling. The samples and blank values were loaded with a total volume of 2 L. Thermal desorption tubes filled with 200 mg TenaxTM TA manufactured by the company MARKES International were used. The concentrations of each substance in the test gas are in the range from 10 to 200 µg/m³. The analysis was performed using gaschromatography with thermal desorption according to IFA folder 8936.

**The evaluation report contains the following information:**

- cover page with information about the evaluation of this PT scheme
- laboratory means of all samples and measurands
- diagrams of all measurands per sample
- Z-scores of all samples and measurands
- overview of the system blank values
- list of the questions answered by the participants*

The **certificate of attendance** will be uploaded as a separate file.

**Please note: we may have adjusted your answers in the report so that laboratory numbers cannot be assigned to the participants.*

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 1

Summary of laboratory means

Sample 1

	Benzene	Z score	1-Butanol	Z score	n-Butyl acetate	Z score	Cumene	Z score
Unit	µg/m³		µg/m³		µg/m³		µg/m³	
2	33.00	-0.4	72.50	3.5 FE	99.00	0.9	50.50	-0.2
26	27.00	-2.1 E	17.00	-6.8 FE	84.00	-0.8	39.00	-2.4 E
43	36.90	0.8	61.10	1.4	106.00	1.7	57.60	1.2
95	24.00	-3.0 E	43.10	-1.9	72.70	-2.0 E	37.30	-2.8 CE
111	39.70	1.6	54.00	0.1	99.60	0.9	55.60	0.8
116	35.60	0.4	62.80	1.7	100.60	1.1	58.40	1.3
137	41.50	2.1 E	83.00	5.5 FE	95.00	0.4	75.50	4.6 FE
143	32.75	-0.4	50.45	-0.6	89.55	-0.2	47.50	-0.8
154	30.00	-1.3	17.33	-6.8 FE	84.00	-0.8	42.67	-1.7
170	37.00	0.8	55.00	0.3	81.00	-1.1	59.00	1.4
228	35.20	0.3					53.52	0.4
240	37.50	0.9	52.20	-0.2	94.20	0.4	53.60	0.4
263	37.10	0.8	58.80	1.0	97.55	0.7 C	53.20	0.3
265	39.00	1.4	52.00	-0.3	100.00	1.0	52.00	0.1
331	36.00	0.5						
333	33.00	-0.4	73.00	3.6 FE	90.00	-0.1	67.00	3.0 E
-	-	--	-	--	-	--	-	--
Statistical method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	Z <=2.0		Z <=2.0		Z <=2.0		Z <=2.0	
No. of laboratories that submitted results	16		14		14		15	
Mean	34.29		53.52		90.97		51.58	
Reproducibility s.d.	5.02		6.27		9.62		7.18	
Repeatability s.d.	1.14		1.35		0.97		1.10	
Rel. reproducibility s.d.	14.64 %		11.72 %		10.57 %		13.92 %	
SDPA	3.43		5.35		9.10		5.16	

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 1

Summary of laboratory means

Sample 1

	Benzene	Z score	1-Butanol	Z score	n-Butyl acetate	Z score	Cumene	Z score
Rel. SDPA	10.00 %		10.00 %		10.00 %		10.00 %	
Reference value	36.60		54.20		88.50		51.80	
Lower limit of tolerance	27.43		42.82		72.78		41.26	
Upper limit of tolerance	41.15		64.23		109.17		61.89	
Type B outliers								
Type C outliers					1		1	
Type F outliers			5				1	
No. of measurement values outside of tolerance limits	5		9		1		7	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	16		9		13		13	
Explanation of outlier types								
A: Single outlier	Grubbs							
B: Differing laboratory mean	Grubbs							
C: Excessive laboratory s.d.	Cochran							
D: Excluded manually								
E: mean outside tolerance limits								
F: Z-Score >3.5								

	n-Decane	Z score	Ethyl benzene	Z score	Naphtalene	Z score	Toluene	Z score
Unit	µg/m³		µg/m³		µg/m³		µg/m³	
2	110.00	-0.2	33.00	0.1	30.00	-0.8	25.00	-0.9
26	105.00	-0.6	27.00	-1.8	23.00	-2.9 E	22.00	-2.0 E
43	127.00	1.3	37.70	1.5	36.50	1.2	31.30	1.3

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 1

Summary of laboratory means

Sample 1

	n-Decane	Z score	Ethyl benzene	Z score	Naphtalene	Z score	Toluene	Z score
95	86.90	-2.2 CE	26.75	-1.8	30.90	-0.5	23.25	-1.6
111	113.50	0.1	38.00	1.6	34.25	0.5	31.80	1.5
116	127.00	1.3	36.40	1.1	37.00	1.4	33.50	2.1 E
137	150.00	3.4 BE	53.00	6.2 BE	43.00	3.2 E	43.50	5.8 BE
143	109.00	-0.3	35.25	0.7	35.55	0.9	29.40	0.7
154	103.33	-0.8	29.67	-1.0	27.33	-1.6	24.00	-1.3
170	107.00	-0.4	37.00	1.3	70.00	11.5 BE	32.00	1.6
228			35.00	0.7			29.58	0.7
240	105.30	-0.6	35.20	0.7	35.80	1.0	31.10	1.3
263	125.00	1.2	32.80	0.0	31.30	-0.4	27.65	0.0
265	105.00	-0.6	33.00	0.1	30.00	-0.8	27.00	-0.2
331			31.50	-0.4	28.50	-1.2		
333	186.00	6.6 BE	30.00	-0.9	41.00	2.6 E	27.00	-0.2
-	-	--	-	--	-	--	-	--
Statistical method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	Z <=2.0		Z <=2.0		Z <=2.0		Z <=2.0	
No. of laboratories that submitted results	14		16		15		15	
Mean	111.94		32.80		32.52		27.60	
Reproducibility s.d.	8.83		3.77		5.59		3.69	
Repeatability s.d.	1.04		0.98		0.75		0.90	
Rel. reproducibility s.d.	7.88 %		11.48 %		17.18 %		13.37 %	
SDPA	11.19		3.28		3.25		2.76	
Rel. SDPA	10.00 %		10.00 %		10.00 %		10.00 %	
Reference value	104.80		34.90		31.90		29.80	
Lower limit of tolerance	89.55		26.24		26.02		22.08	
Upper limit of tolerance	134.33		39.36		39.02		33.12	

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 1

Summary of laboratory means

Sample 1

	n-Decane	Z score	Ethyl benzene	Z score	Naphtalene	Z score	Toluene	Z score
Type B outliers	2		1		1		1	
Type C outliers	1							
No. of measurement values outside of tolerance limits	4		2		6		5	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	11		15		14		14	

	1,2,3-Trimethylbenzene	Z score	p-Xylene	Z score
Unit	µg/m³		µg/m³	
2	58.00	-0.6	67.50	0.0
26	46.00	-2.5 E	54.00	-2.0
43	71.80	1.7	71.80	0.6
95	56.25	-0.9	57.45	-1.5
111	72.75	1.8	75.85	1.2
116	74.10	2.0 E	74.10	1.0
137	92.50	5.0 FE	120.00	7.8 BE
143	62.55	0.2	68.80	0.2
154	48.33	-2.2 E	56.67	-1.6
170	65.00	0.6	77.00	1.4
228	70.97	1.5	73.65	0.9
240	68.60	1.1	71.70	0.6
263	60.40	-0.2	75.90	1.2
265	58.00	-0.6	68.00	0.1
331			67.00	-0.1
333	67.00	0.9	63.00	-0.7

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 1

Summary of laboratory means

Sample 1

	1,2,3-Trimethylbenzene	Z score	p-Xylene	Z score
–	–	--	–	--
Statistical method	ISO 5725-2		ISO 5725-2	
Assessment	Z <=2.0		Z <=2.0	
No. of laboratories that submitted results	15		16	
Mean	61.59		67.47	
Reproducibility s.d.	9.26		7.85	
Repeatability s.d.	1.85		1.57	
Rel. reproducibility s.d.	15.04 %		11.64 %	
SDPA	6.16		6.75	
Rel. SDPA	10.00 %		10.00 %	
Reference value	63.40		72.00	
Lower limit of tolerance	49.27		53.97	
Upper limit of tolerance	73.91		80.96	
Type B outliers			1	
Type F outliers	1			
No. of measurement values outside of tolerance limits	7		2	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	14		15	

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 2

Summary of laboratory means

Sample 2

	Benzene	Z score	1-Butanol	Z score	n-Butyl acetate	Z score	Cumene	Z score
Unit	µg/m³		µg/m³		µg/m³		µg/m³	
2	46.50	0.2	115.00	5.4 FE	36.50	1.2	65.50	0.0
26	39.00	-1.5	25.00	-6.7 FE	31.00	-0.5	52.00	-2.0 E
43	49.50	0.8	84.60	1.3	35.90	1.0	74.00	1.3
95	30.50	-3.3 E	57.95	-2.3 E	25.80	-2.1 E	53.15	-1.8
111	48.85	0.7	71.25	-0.5	33.60	0.3	65.15	0.0
116	48.70	0.7	98.00	3.1 E	36.80	1.3	76.30	1.7
137	56.00	2.3 E	115.00	5.4 FE	37.50	1.5	96.50	4.8 FE
143	44.50	-0.2	69.55	-0.7	31.85	-0.3	60.65	-0.7
154	38.33	-1.6	22.00	-7.1 FE	32.00	-0.2	53.00	-1.9
170	46.00	0.1	68.00	-0.9	30.00	-0.8	75.00	1.5
228	47.21	0.3					69.06	0.6
240	50.70	1.1	75.90	0.1	35.50	0.9	68.50	0.5
263	51.60	1.3	87.80	1.7	31.30	-0.4	69.00	0.6
265	53.00	1.6	74.00	-0.1	36.00	1.0	64.00	-0.2
331	49.50	0.8						
333	40.00	-1.2	105.50	4.1 FE	29.50	-1.0	83.50	2.8 E
-	-	--	-	--	-	--	-	--
Statistical method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	Z ≤2.0		Z ≤2.0		Z ≤2.0		Z ≤2.0	
No. of laboratories that submitted results	16		14		14		15	
Mean	45.63		74.89		32.71		65.21	
Reproducibility s.d.	6.86		12.17		3.63		9.79	
Repeatability s.d.	1.30		2.30		1.65		1.41	
Rel. reproducibility s.d.	15.03 %		16.25 %		11.10 %		15.01 %	
SDPA	4.56		7.49		3.27		6.52	

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 2

Summary of laboratory means

Sample 2

	Benzene	Z score	1-Butanol	Z score	n-Butyl acetate	Z score	Cumene	Z score
Rel. SDPA	10.00 %		10.00 %		10.00 %		10.00 %	
Reference value	49.20		77.10		32.00		66.80	
Lower limit of tolerance	36.50		59.91		26.17		52.17	
Upper limit of tolerance	54.75		89.87		39.25		78.25	
Type B outliers								
Type C outliers								
Type F outliers			5				1	
No. of measurement values outside of tolerance limits	4		14		2		7	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	16		9		14		14	
Explanation of outlier types								
A: Single outlier	Grubbs							
B: Differing laboratory mean	Grubbs							
C: Excessive laboratory s.d.	Cochran							
D: Excluded manually								
E: mean outside tolerance limits								
F: Z-Score >3.5								

	n-Decane	Z score	Ethyl benzene	Z score	Naphtalene	Z score	Toluene	Z score
Unit	µg/m³		µg/m³		µg/m³		µg/m³	
2	87.00	0.1	99.00	0.7	66.50	-0.6	56.50	-0.3
26	85.00	-0.1	80.00	-1.4	53.00	-2.5 E	51.00	-1.3
43	92.30	0.8	110.00	1.9	77.20	0.9	64.90	1.1

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 2

Summary of laboratory means

Sample 2

	n-Decane	Z score	Ethyl benzene	Z score	Naphtalene	Z score	Toluene	Z score
95	78.95	-0.8	81.10	-1.3	67.20	-0.5	51.95	-1.1
111	81.95	-0.4	96.55	0.4	64.90	-0.8	62.80	0.8
116	100.20	1.7	114.00	2.3 E	82.10	1.6	68.10	1.7
137	120.00	4.0 BE	150.00	6.2 BE	93.00	3.1 E	92.50	5.9 CE
143	82.50	-0.4	99.55	0.7	76.55	0.8	61.95	0.6
154	85.67	0.0	81.33	-1.2	53.67	-2.4 E	52.00	-1.1
170	80.00	-0.7	95.00	0.2	81.00	1.4	64.00	1.0
228			105.81	1.4			64.87	1.1
240	86.40	0.1	99.10	0.7	71.50	0.1	67.60	1.6
263	92.35	0.8	105.50	1.4	70.90	0.0	62.75	0.8
265	84.00	-0.2	89.00	-0.4	62.00	-1.3	57.00	-0.2
331			94.00	0.1 C	67.00	-0.5 C		
333	300.00	25.0 BE	64.50	-3.0 E	82.50	1.6	46.50	-2.0 E
-	-	--	-	--	-	--	-	--
Statistical method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	Z <=2.0		Z <=2.0		Z <=2.0		Z <=2.0	
No. of laboratories that submitted results	14		16		15		15	
Mean	85.78		92.77		70.88		58.36	
Reproducibility s.d.	5.62		13.99		12.00		6.91	
Repeatability s.d.	1.93		1.70		1.78		0.99	
Rel. reproducibility s.d.	6.55 %		15.08 %		16.93 %		11.84 %	
SDPA	8.58		9.28		7.09		5.84	
Rel. SDPA	10.00 %		10.00 %		10.00 %		10.00 %	
Reference value	82.10		101.50		68.50		65.20	
Lower limit of tolerance	68.62		74.22		56.70		46.69	
Upper limit of tolerance	102.93		111.33		85.06		70.03	

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 2

Summary of laboratory means

Sample 2

	n-Decane	Z score	Ethyl benzene	Z score	Naphtalene	Z score	Toluene	Z score
Type B outliers	2		1					
Type C outliers			1		1		1	
No. of measurement values outside of tolerance limits	4		5		6		3	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	12		14		14		14	

	1,2,3-Trimethylbenzene	Z score	p-Xylene	Z score
Unit	µg/m³		µg/m³	
2	25.50	-0.5	40.50	0.1
26	21.00	-2.2 E	33.00	-1.8
43	32.30	2.0 E	45.00	1.2
95	23.95	-1.1	32.55	-1.9
111	29.80	1.1	42.25	0.5
116	31.80	1.9	43.80	0.9
137	41.50	5.5 FE	74.50	8.6 BE
143	27.50	0.3	41.00	0.2
154	21.00	-2.2 E	33.33	-1.7
170	29.00	0.8	41.00	0.2
228	31.56	1.8	43.48	0.8
240	32.80	2.2 E	43.80	0.9
263	23.60	-1.2	43.35	0.8
265	26.00	-0.3	41.00	0.2
331			39.50	-0.2 C
333	28.50	0.6	45.00	1.2

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Sample 2

Summary of laboratory means

Sample 2

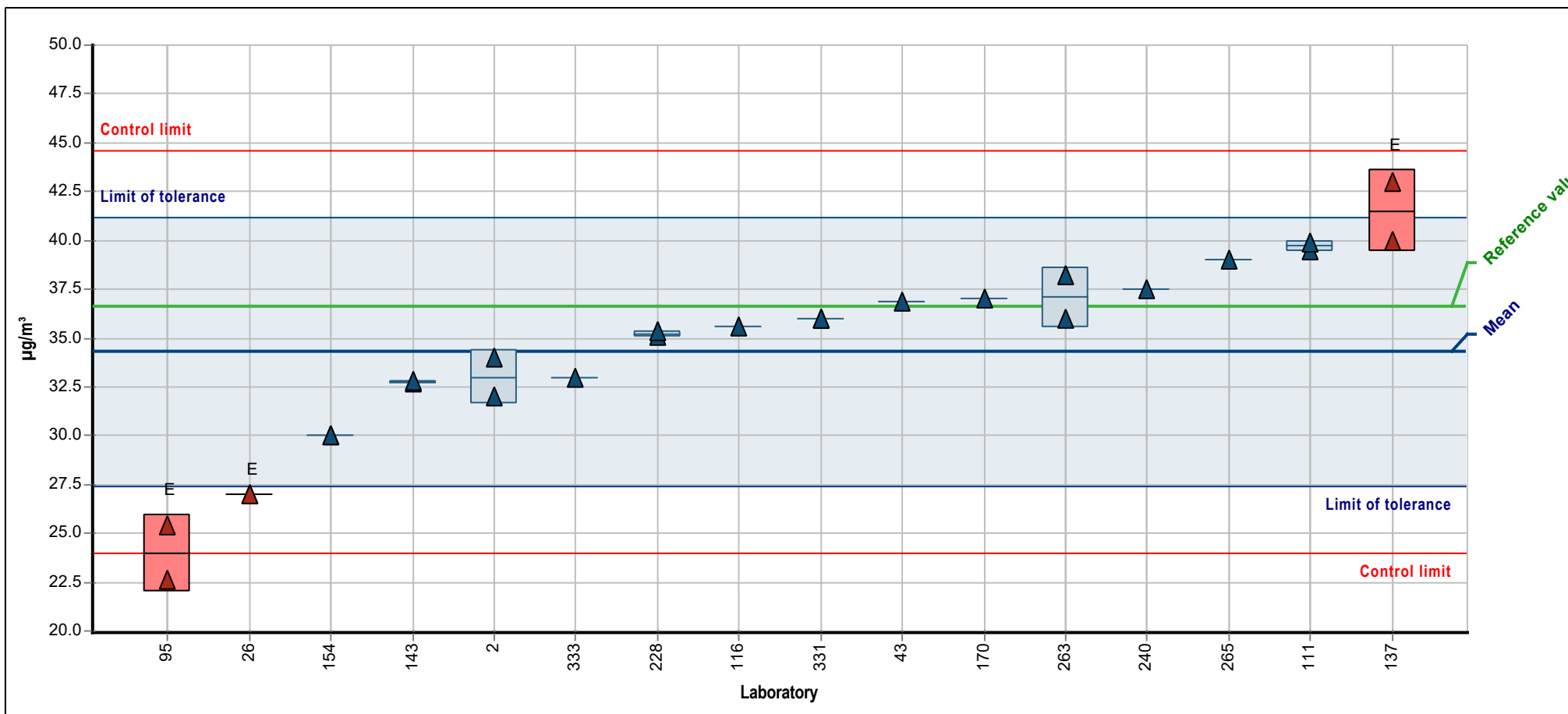
	1,2,3-Trimethylbenzene	Z score	p-Xylene	Z score
–	–	--	–	--
Statistical method	ISO 5725-2		ISO 5725-2	
Assessment	Z <=2.0		Z <=2.0	
No. of laboratories that submitted results	15		16	
Mean	26.81		40.15	
Reproducibility s.d.	4.02		4.71	
Repeatability s.d.	0.49		1.00	
Rel. reproducibility s.d.	15.01 %		11.73 %	
SDPA	2.68		4.02	
Rel. SDPA	10.00 %		10.00 %	
Reference value	27.90		42.70	
Lower limit of tolerance	21.45		32.12	
Upper limit of tolerance	32.18		48.18	
Type B outliers			1	
Type C outliers			1	
Type F outliers	1			
No. of measurement values outside of tolerance limits	8		3	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	14		14	

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: Benzene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 16

Mean: 34.29 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 14.64%
 Reproducibility s.d.: 5.02 $\mu\text{g}/\text{m}^3$
 Reference value: 36.60 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 27.43 - 41.15 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 24.00 and 44.58 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

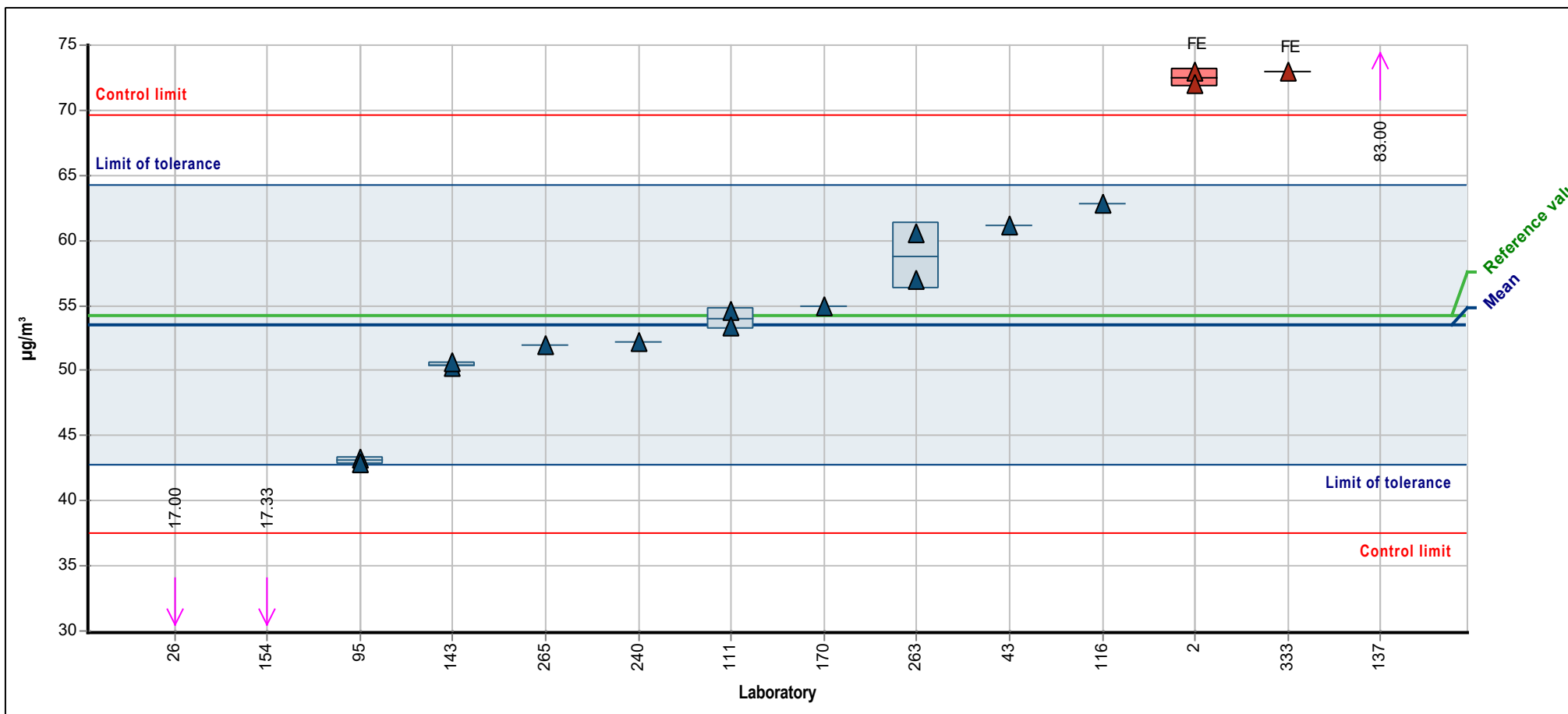


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: 1-Butanol
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 9

Mean: 53.52 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 11.72%
 Reproducibility s.d.: 6.27 $\mu\text{g}/\text{m}^3$
 Reference value: 54.20 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 42.82 - 64.23 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 37.47 and 69.58 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

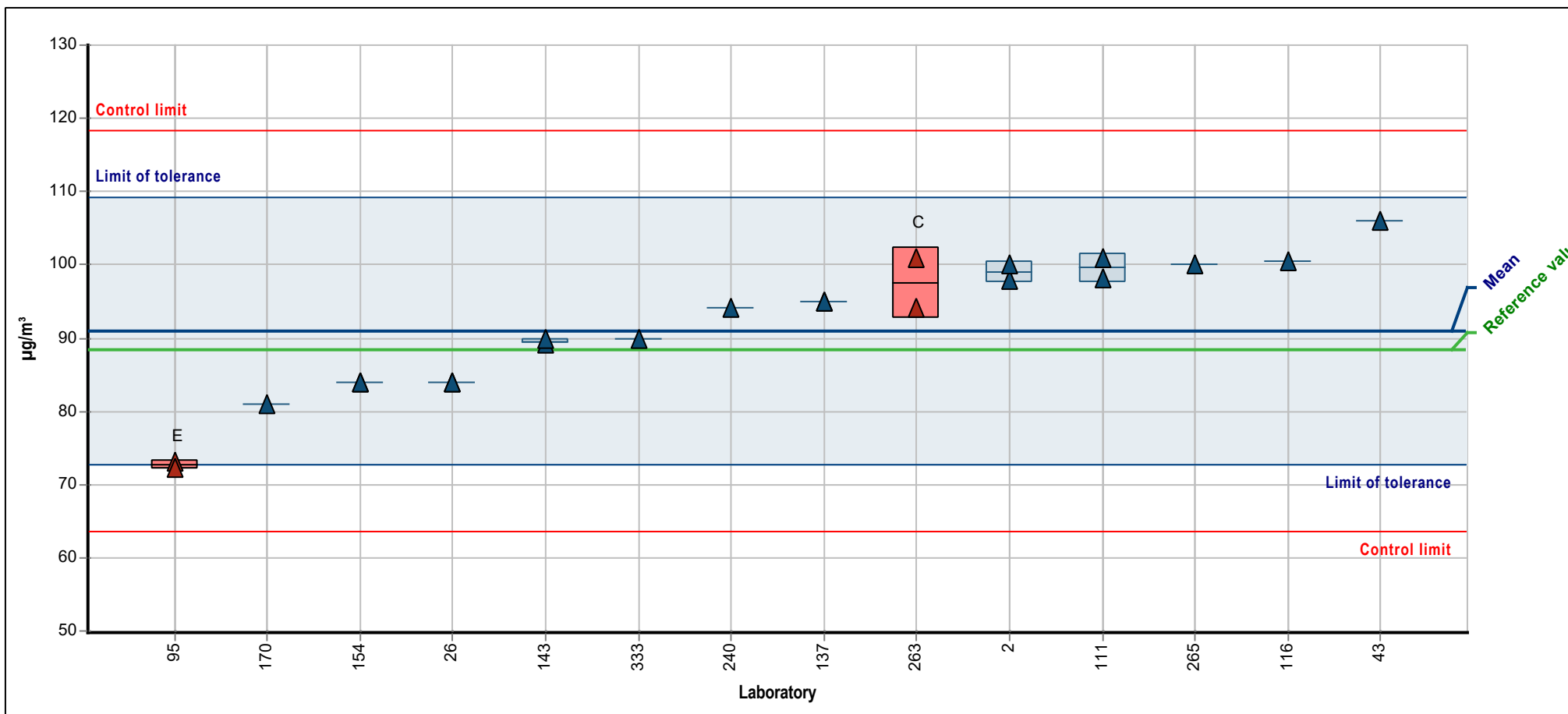


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
Measurand: n-Butyl acetate
Statistical method: ISO 5725-2
Rel. SDPA: 10.00%
Number of laboratories in calculation: 13

Mean: 90.97 $\mu\text{g}/\text{m}^3$
Rel. reproducibility s.d.: 10.57%
Reproducibility s.d.: 9.62 $\mu\text{g}/\text{m}^3$
Reference value: 88.50 $\mu\text{g}/\text{m}^3$
Range of tolerance: 72.78 - 109.17 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
Control limits: 63.68 and 118.27 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

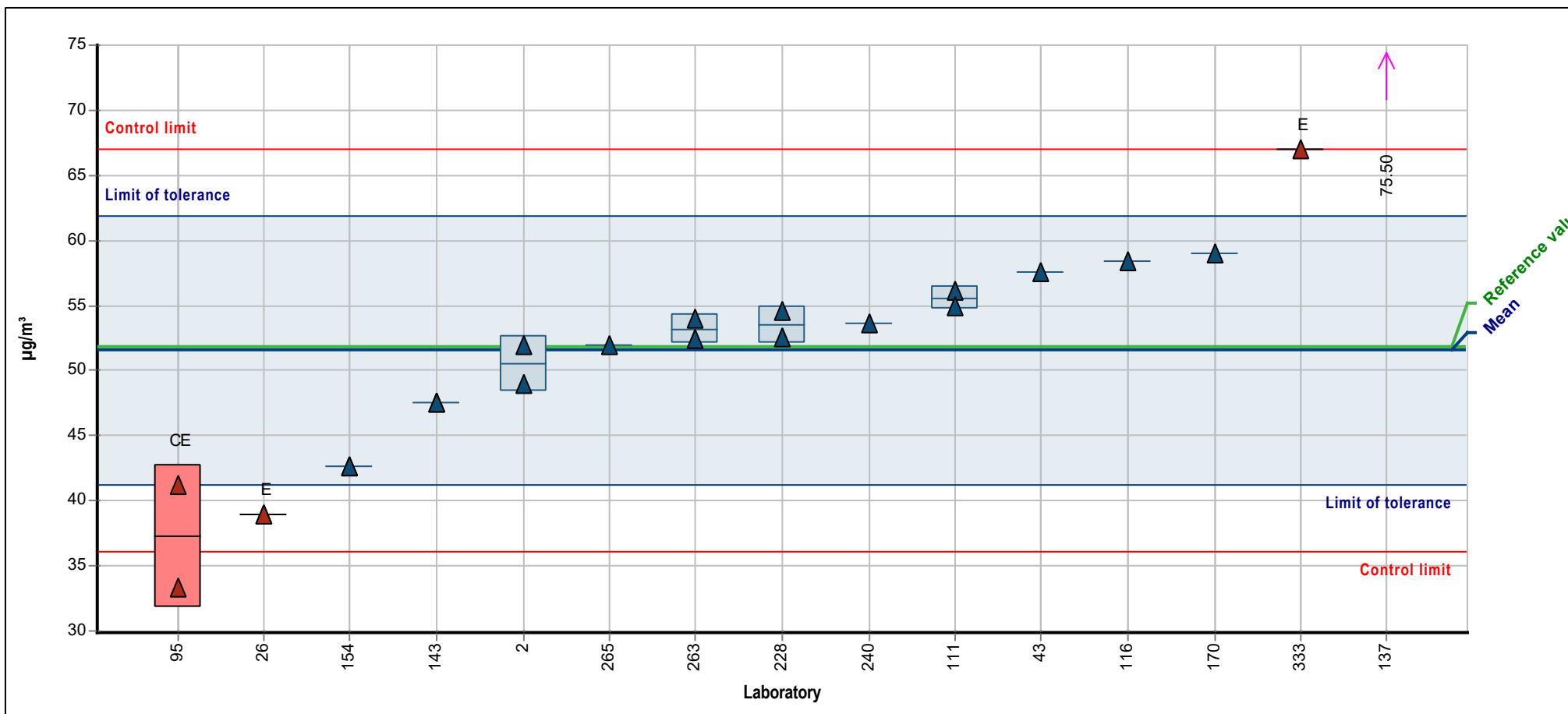


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: Cumene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 13

Mean: 51.58 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 13.92%
 Reproducibility s.d.: 7.18 $\mu\text{g}/\text{m}^3$
 Reference value: 51.80 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 41.26 - 61.89 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 36.11 and 67.05 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

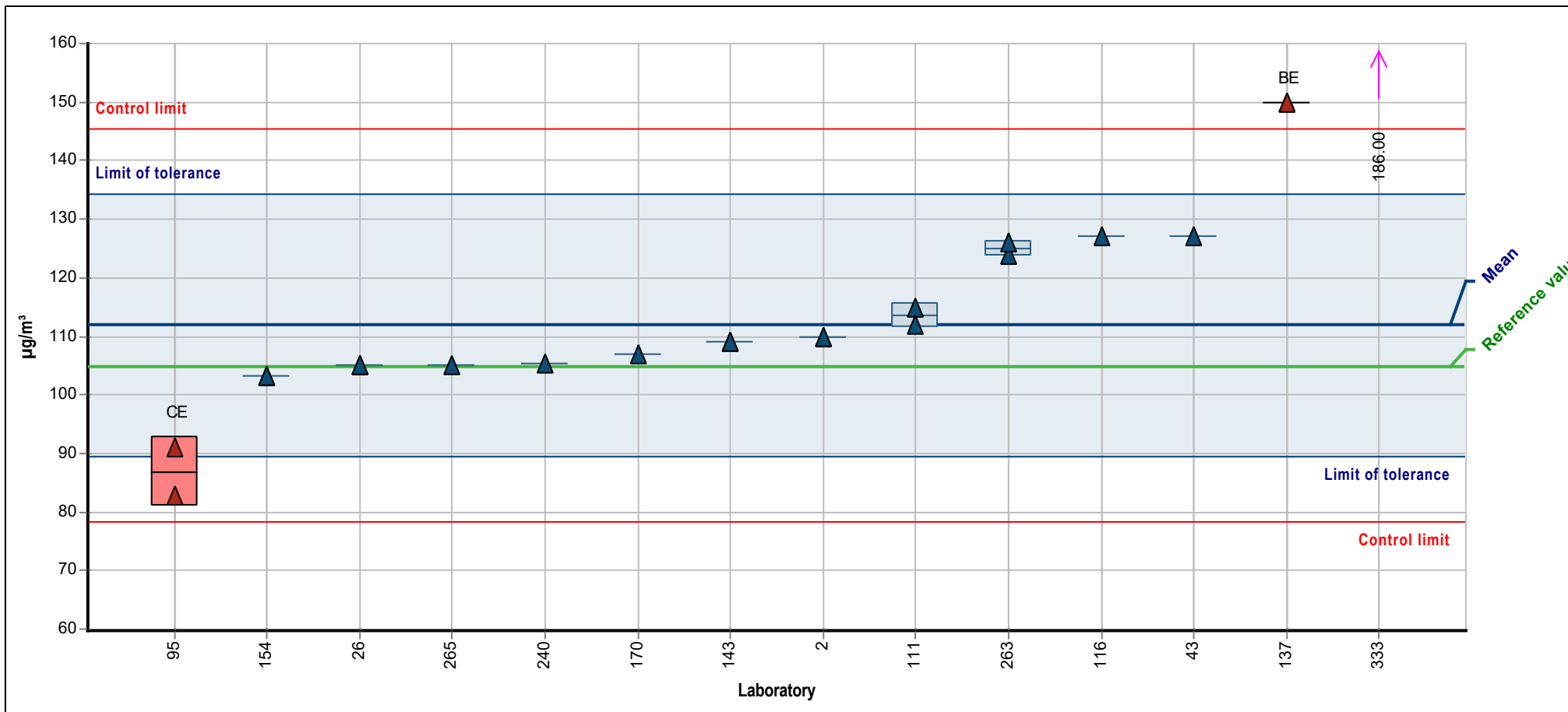


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: n-Decane
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 11

Mean: 111.94 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 7.88%
 Reproducibility s.d.: 8.83 $\mu\text{g}/\text{m}^3$
 Reference value: 104.80 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 89.55 - 134.33 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 78.36 and 145.52 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

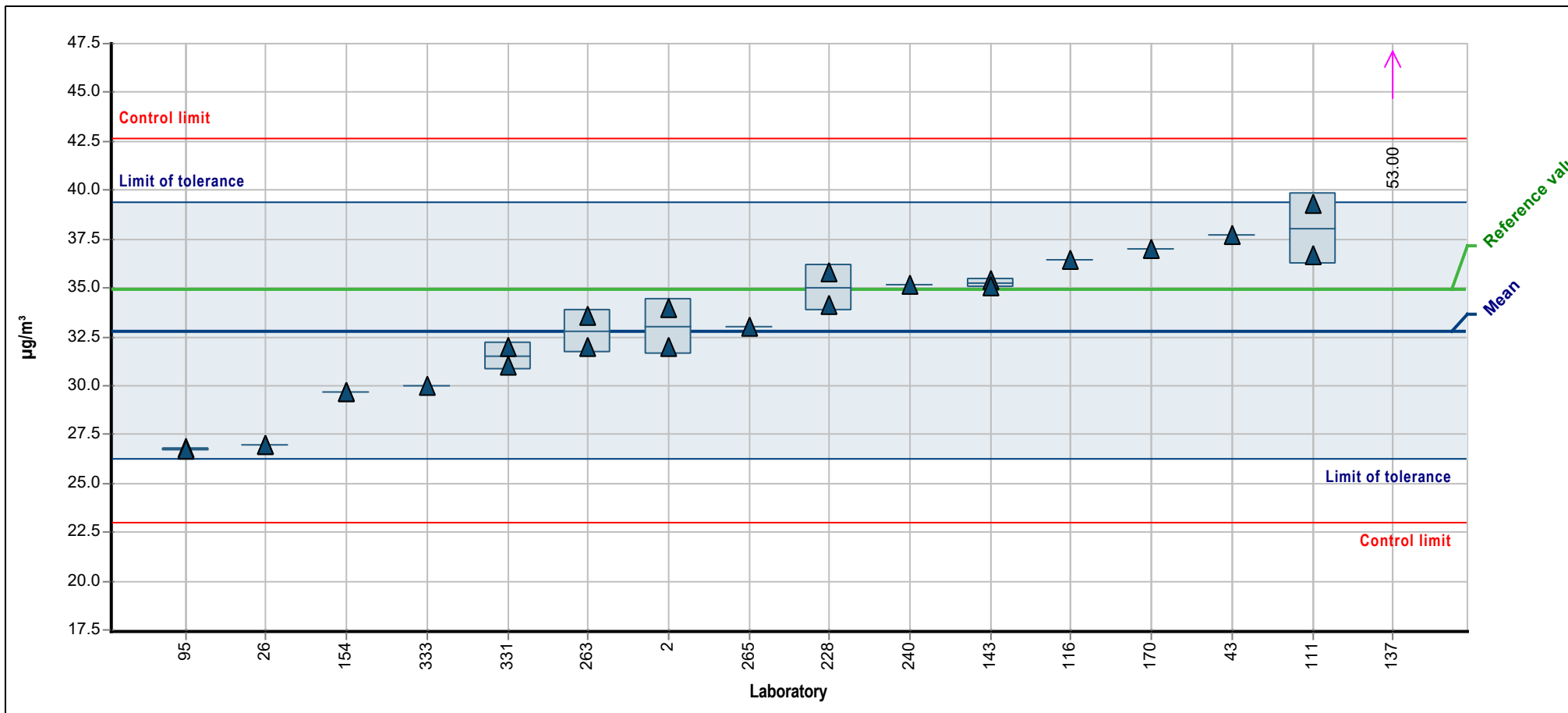


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: Ethyl benzene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 15

Mean: 32.80 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 11.48%
 Reproducibility s.d.: 3.77 $\mu\text{g}/\text{m}^3$
 Reference value: 34.90 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 26.24 - 39.36 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 22.96 and 42.64 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

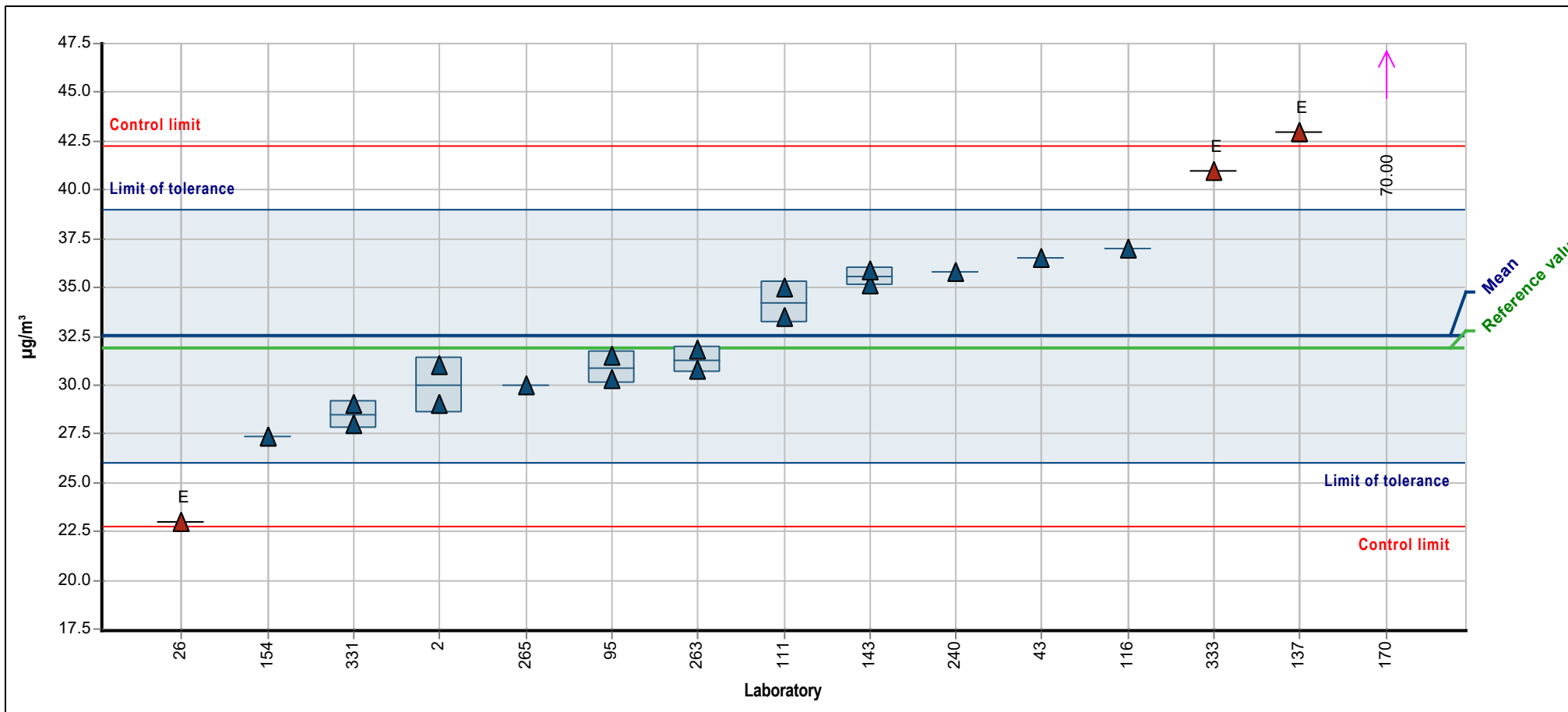


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: Naphtalene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 32.52 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 17.18%
 Reproducibility s.d.: 5.59 $\mu\text{g}/\text{m}^3$
 Reference value: 31.90 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 26.02 - 39.02 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 22.76 and 42.28 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

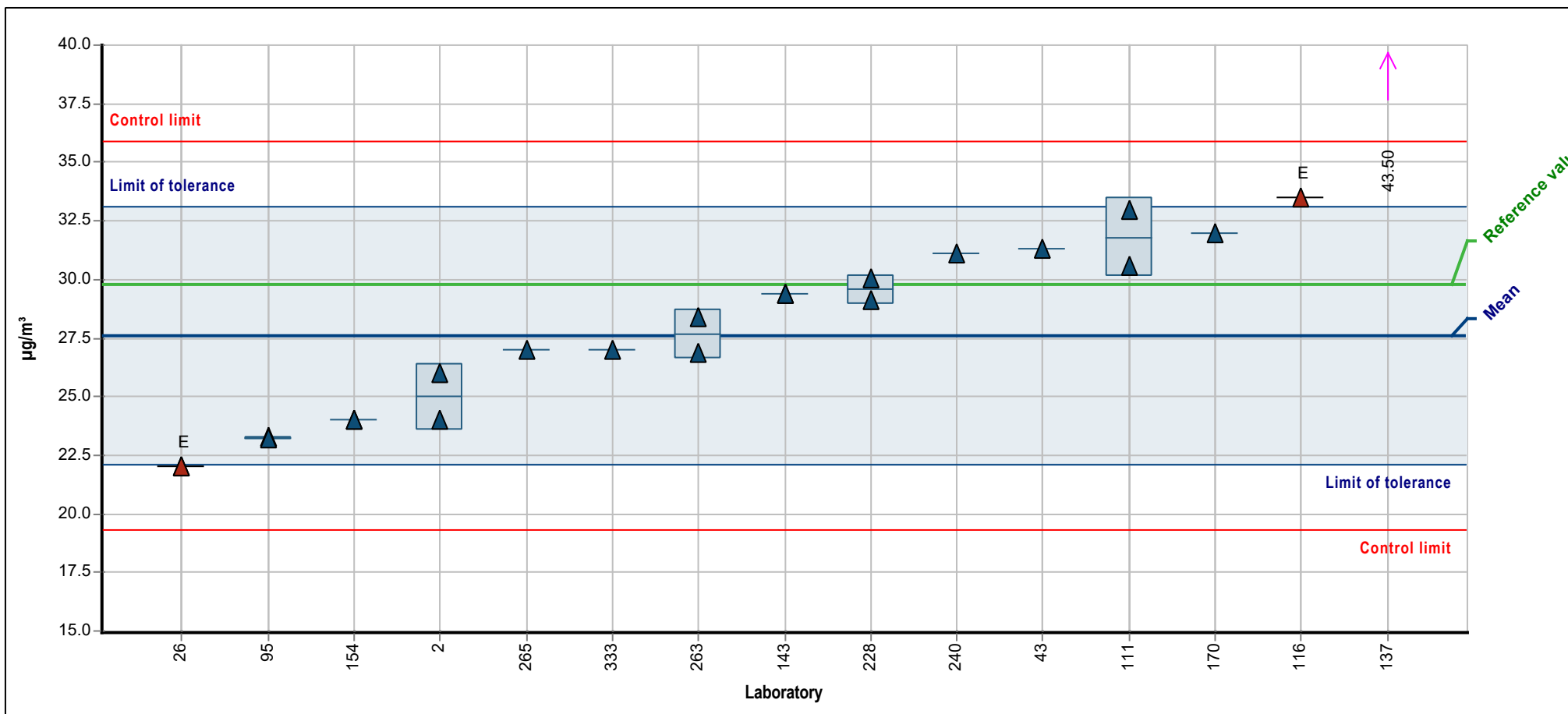


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: Toluene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 27.60 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 13.37%
 Reproducibility s.d.: 3.69 $\mu\text{g}/\text{m}^3$
 Reference value: 29.80 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 22.08 - 33.12 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 19.32 and 35.88 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

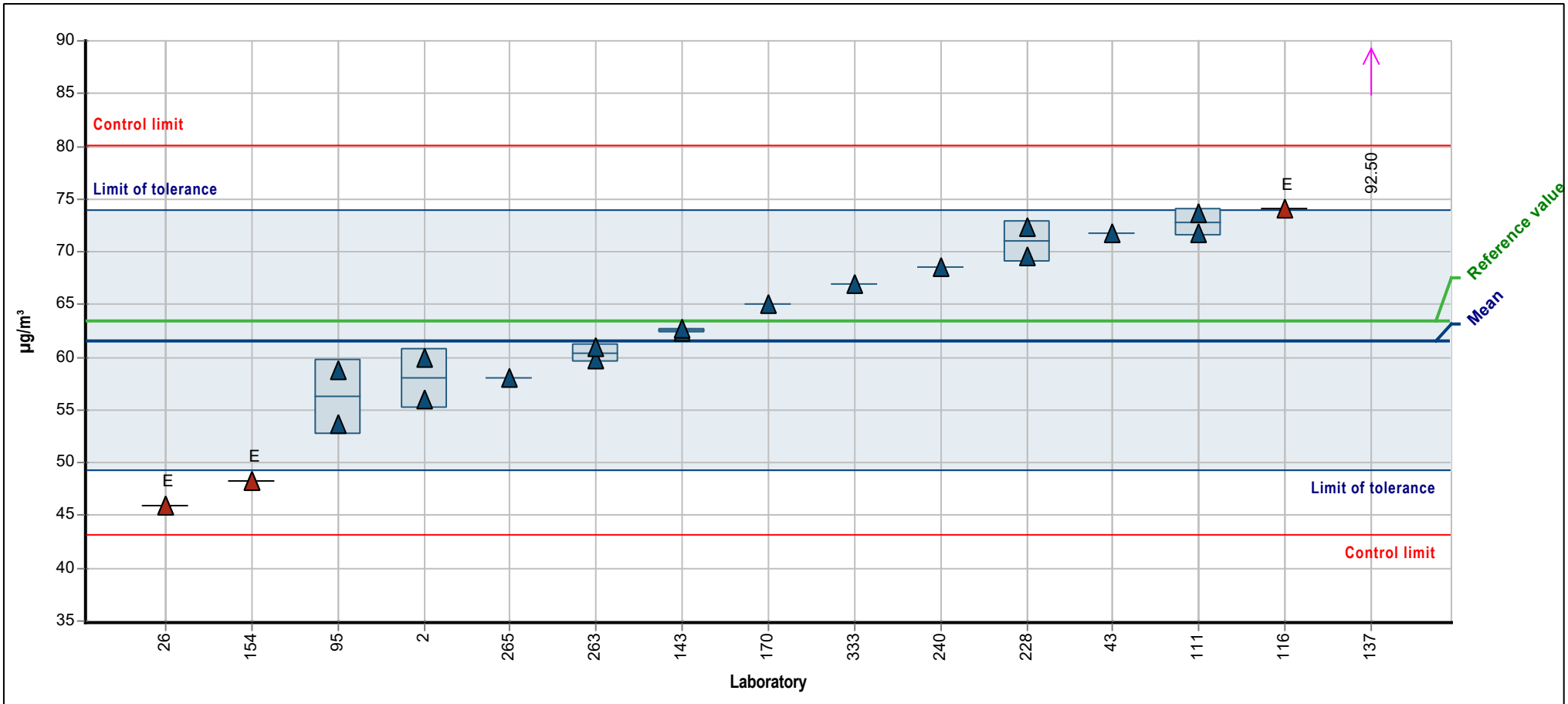


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: 1,2,3-Trimethylbenzene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 61.59 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 15.04%
 Reproducibility s.d.: 9.26 $\mu\text{g}/\text{m}^3$
 Reference value: 63.40 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 49.27 - 73.91 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 43.11 and 80.07 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

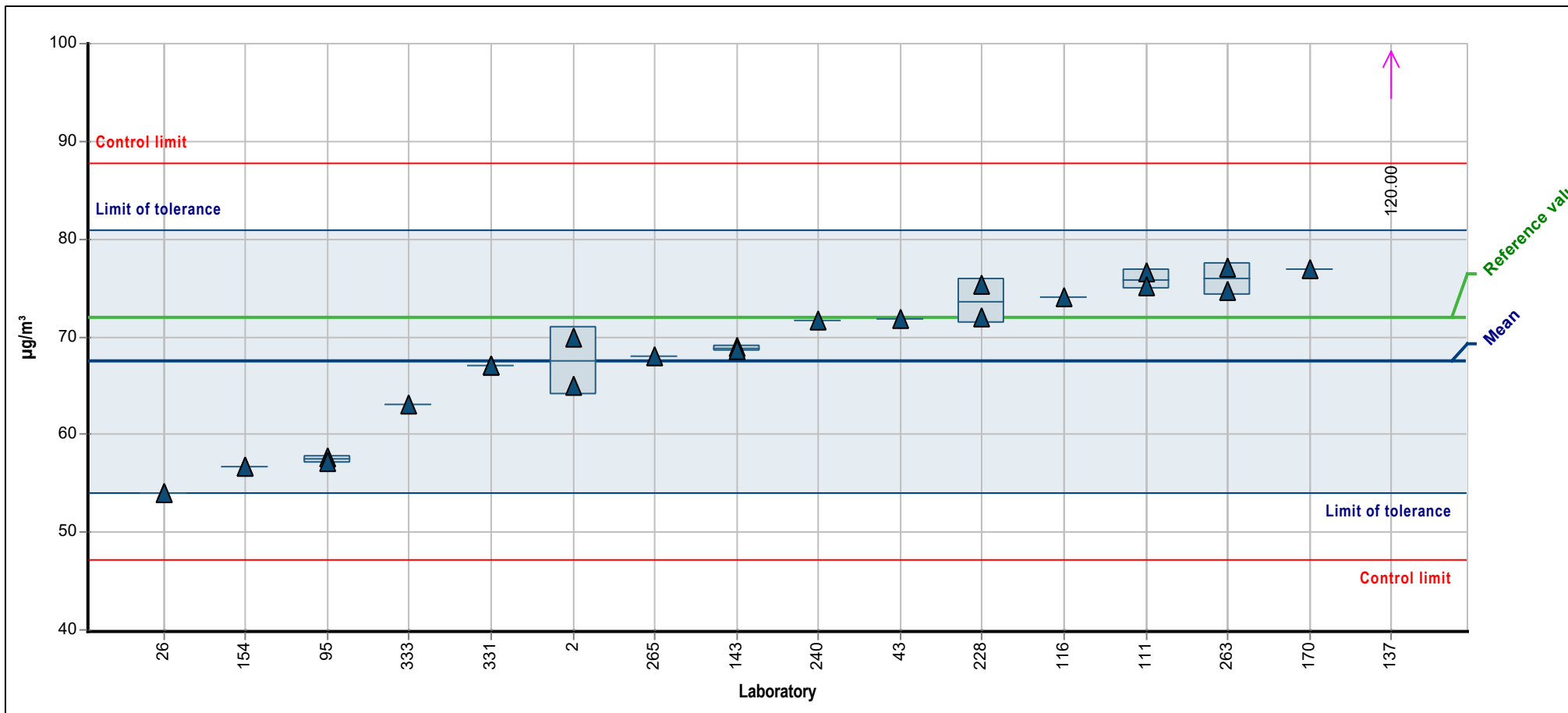


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 1
 Measurand: p-Xylene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 15

Mean: 67.47 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 11.64%
 Reproducibility s.d.: 7.85 $\mu\text{g}/\text{m}^3$
 Reference value: 72.00 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 53.97 - 80.96 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 47.23 and 87.71 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

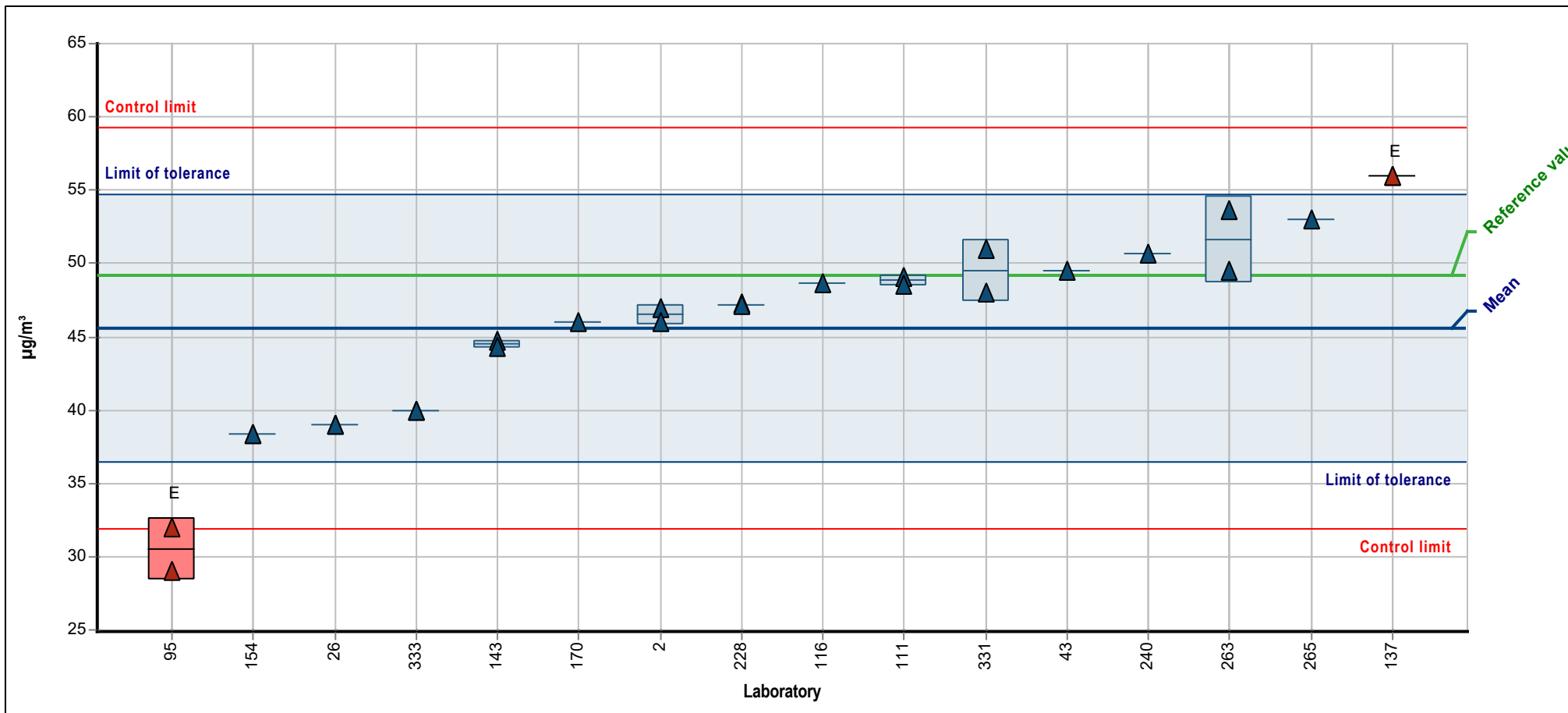


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
 Measurand: Benzene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 16

Mean: 45.63 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 15.03%
 Reproducibility s.d.: 6.86 $\mu\text{g}/\text{m}^3$
 Reference value: 49.20 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 36.50 - 54.75 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 31.94 and 59.31 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

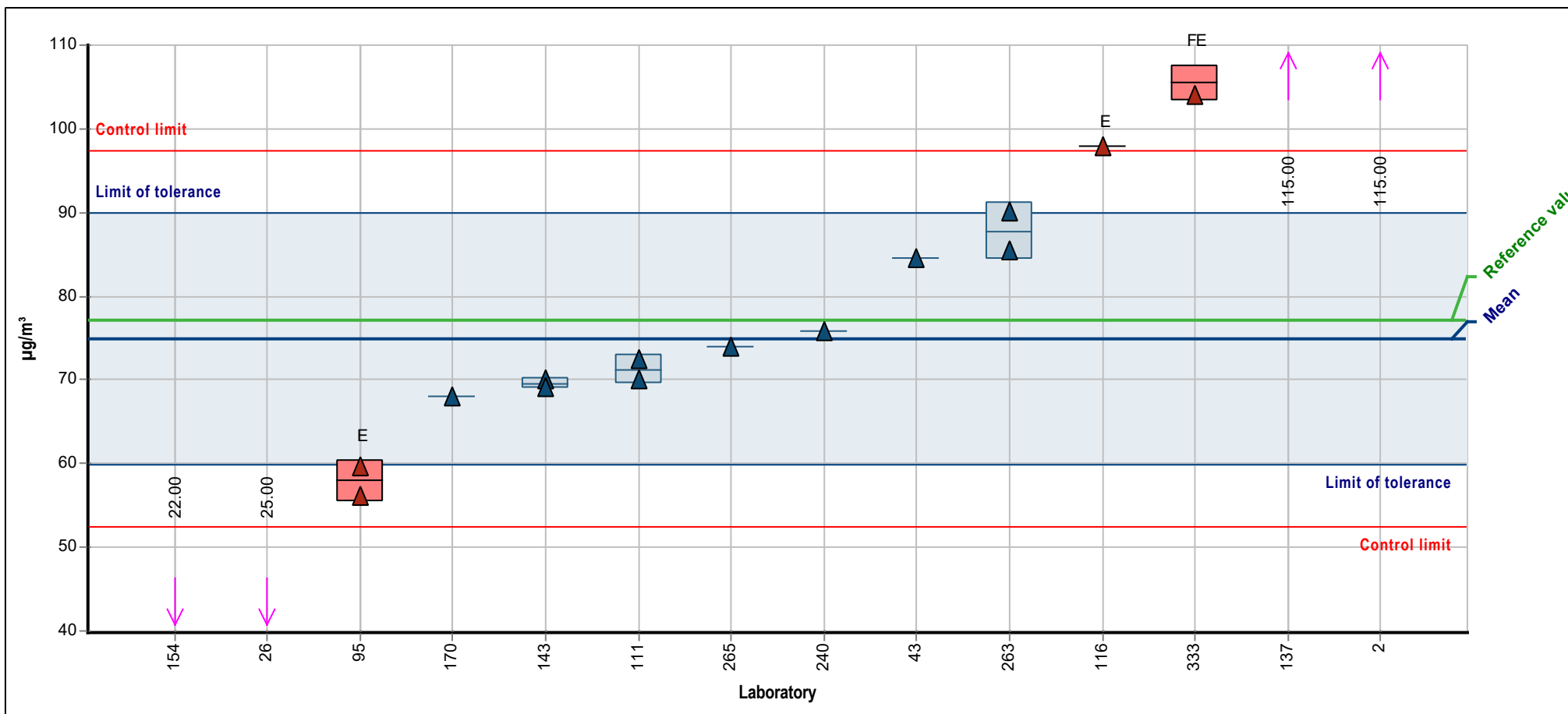


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
 Measurand: 1-Butanol
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 9

Mean: 74.89 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 16.25%
 Reproducibility s.d.: 12.17 $\mu\text{g}/\text{m}^3$
 Reference value: 77.10 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 59.91 - 89.87 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 52.42 and 97.36 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

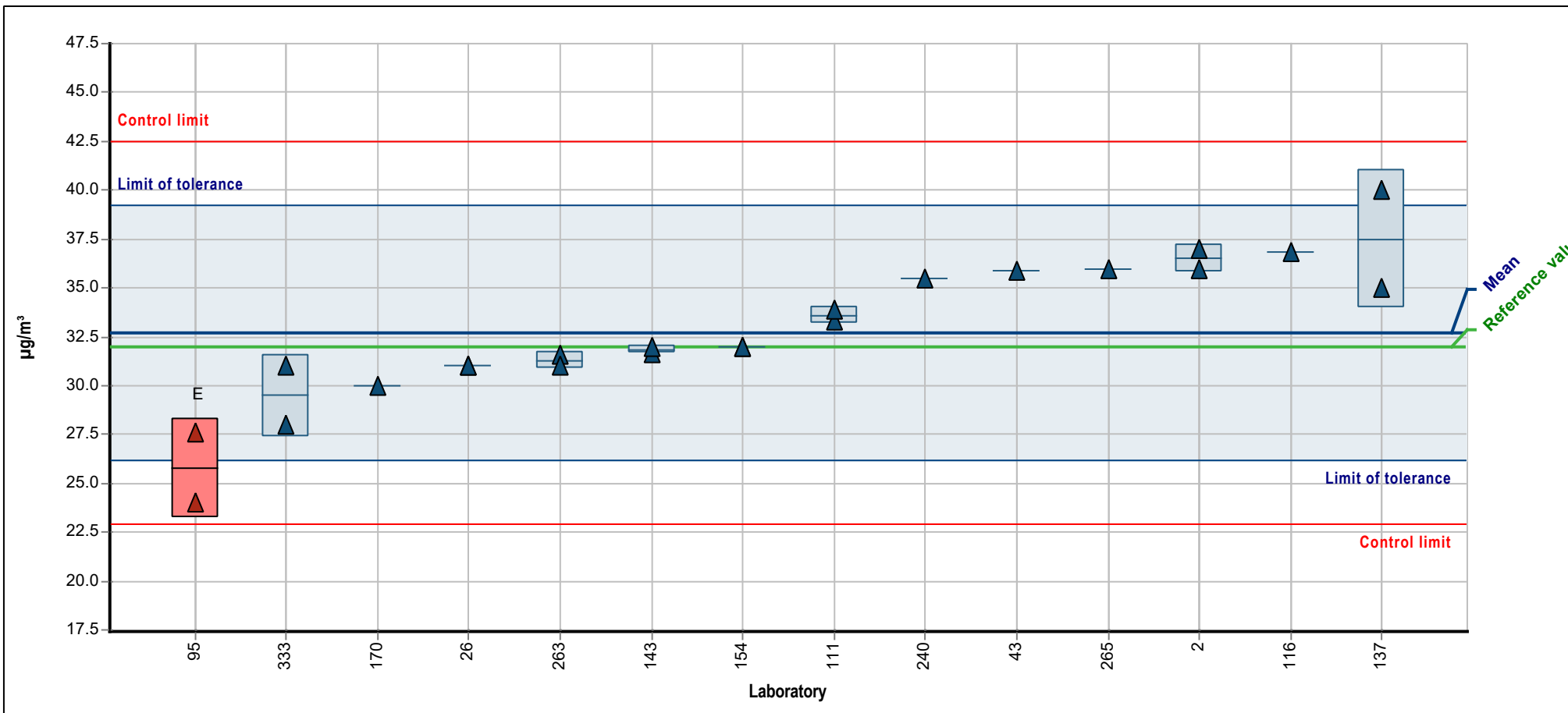


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
Measurand: n-Butyl acetate
Statistical method: ISO 5725-2
Rel. SDPA: 10.00%
Number of laboratories in calculation: 14

Mean: 32.71 $\mu\text{g}/\text{m}^3$
Rel. reproducibility s.d.: 11.10%
Reproducibility s.d.: 3.63 $\mu\text{g}/\text{m}^3$
Reference value: 32.00 $\mu\text{g}/\text{m}^3$
Range of tolerance: 26.17 - 39.25 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
Control limits: 22.90 and 42.52 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

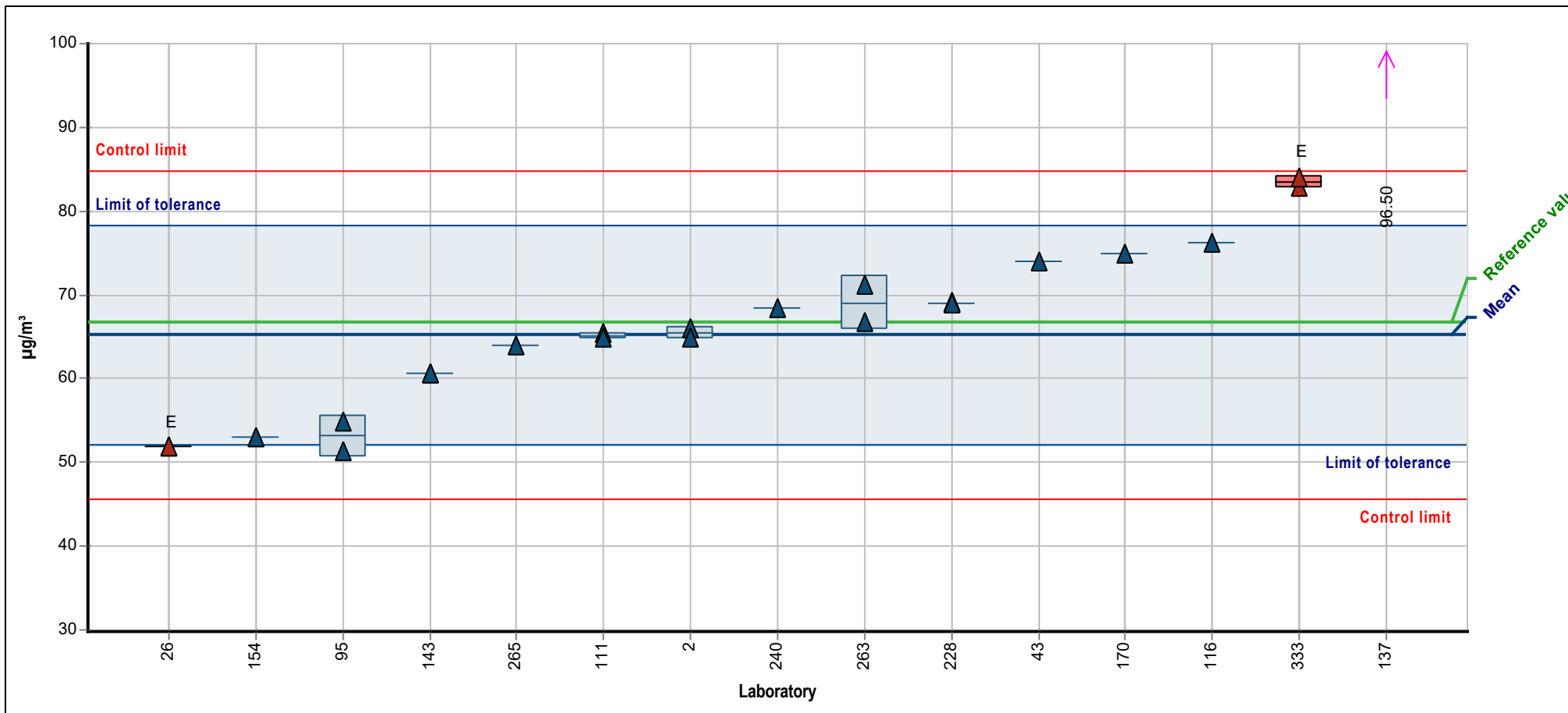


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
 Measurand: Cumene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 65.21 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 15.01%
 Reproducibility s.d.: 9.79 $\mu\text{g}/\text{m}^3$
 Reference value: 66.80 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 52.17 - 78.25 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 45.65 and 84.77 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

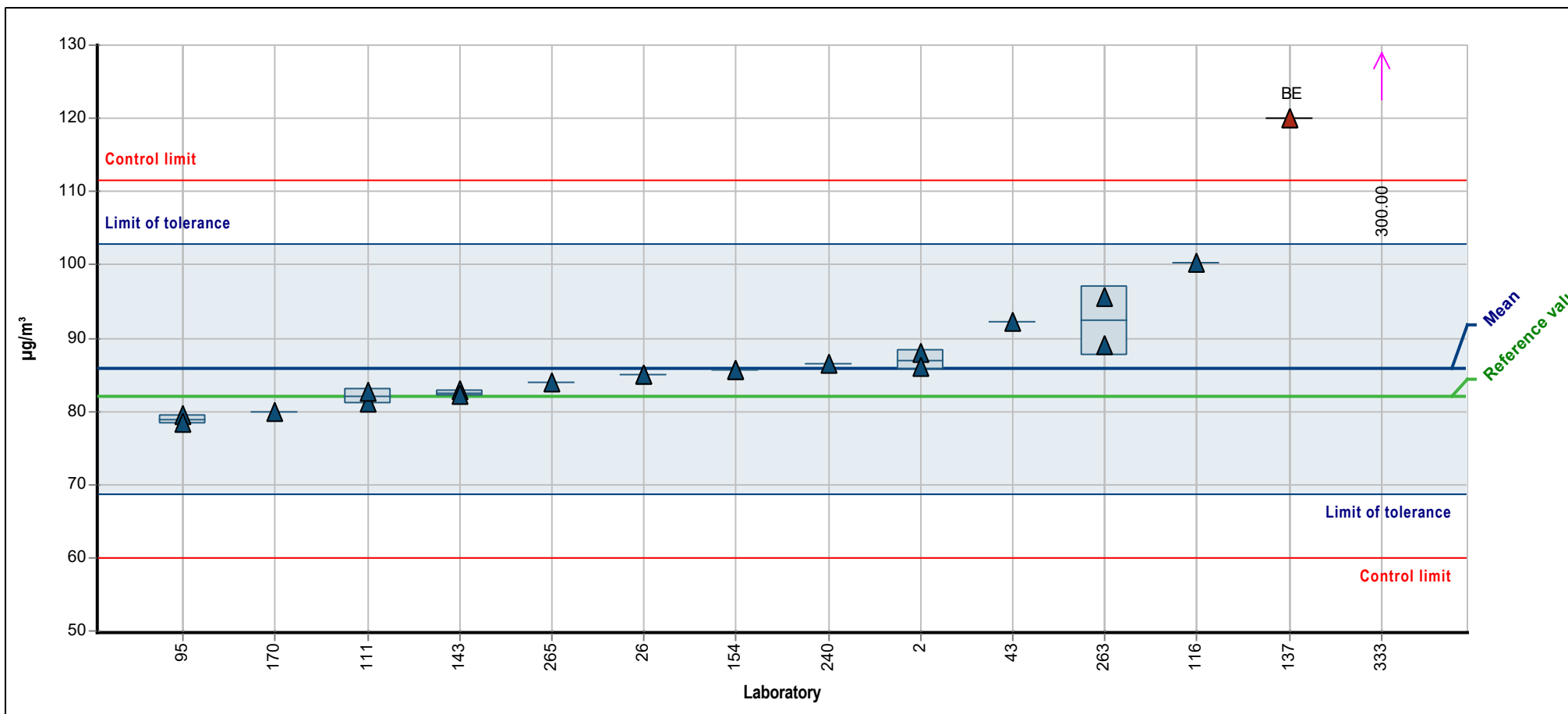


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
 Measurand: n-Decane
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 12

Mean: 85.78 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 6.55%
 Reproducibility s.d.: 5.62 $\mu\text{g}/\text{m}^3$
 Reference value: 82.10 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 68.62 - 102.93 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 60.04 and 111.51 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

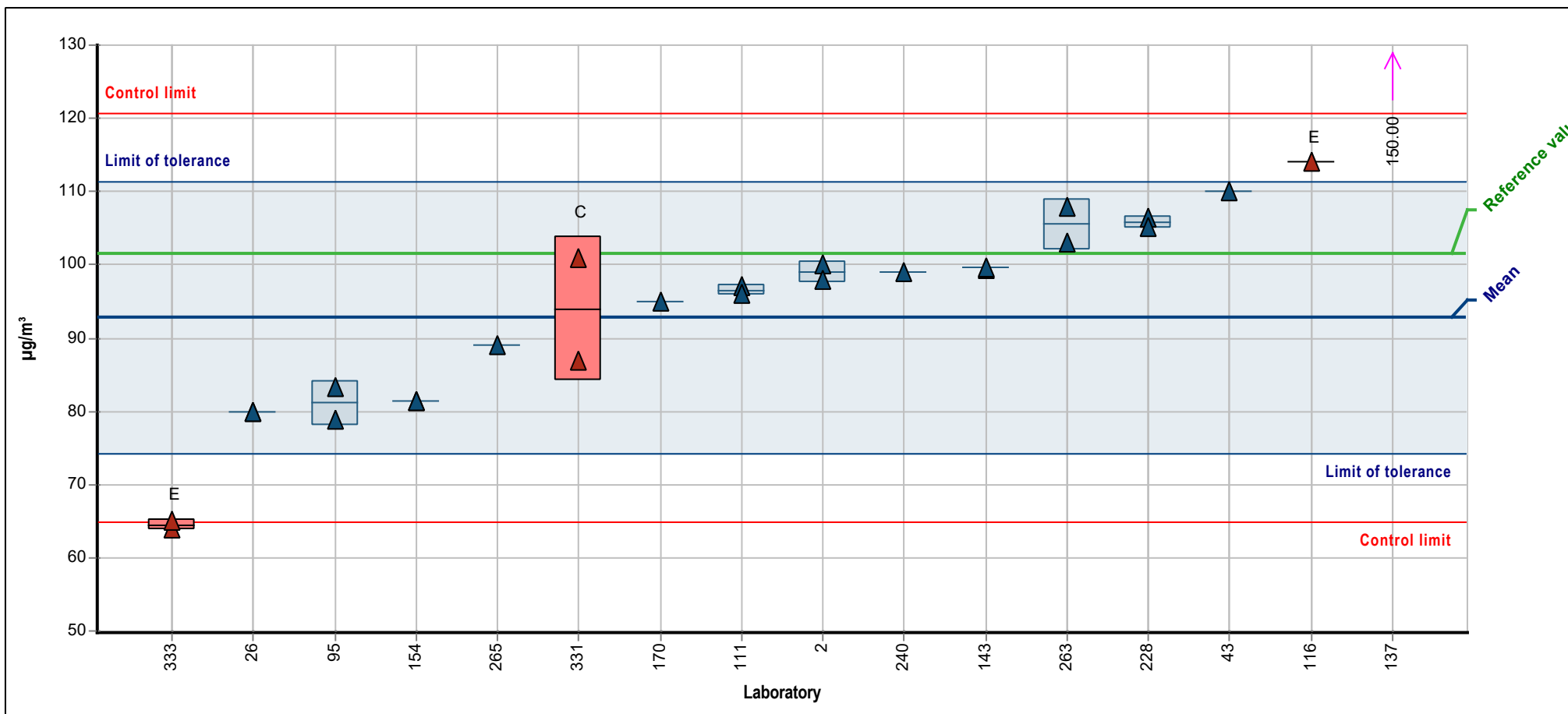


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
 Measurand: Ethyl benzene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 92.77 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 15.08%
 Reproducibility s.d.: 13.99 $\mu\text{g}/\text{m}^3$
 Reference value: 101.50 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 74.22 - 111.33 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 64.94 and 120.60 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

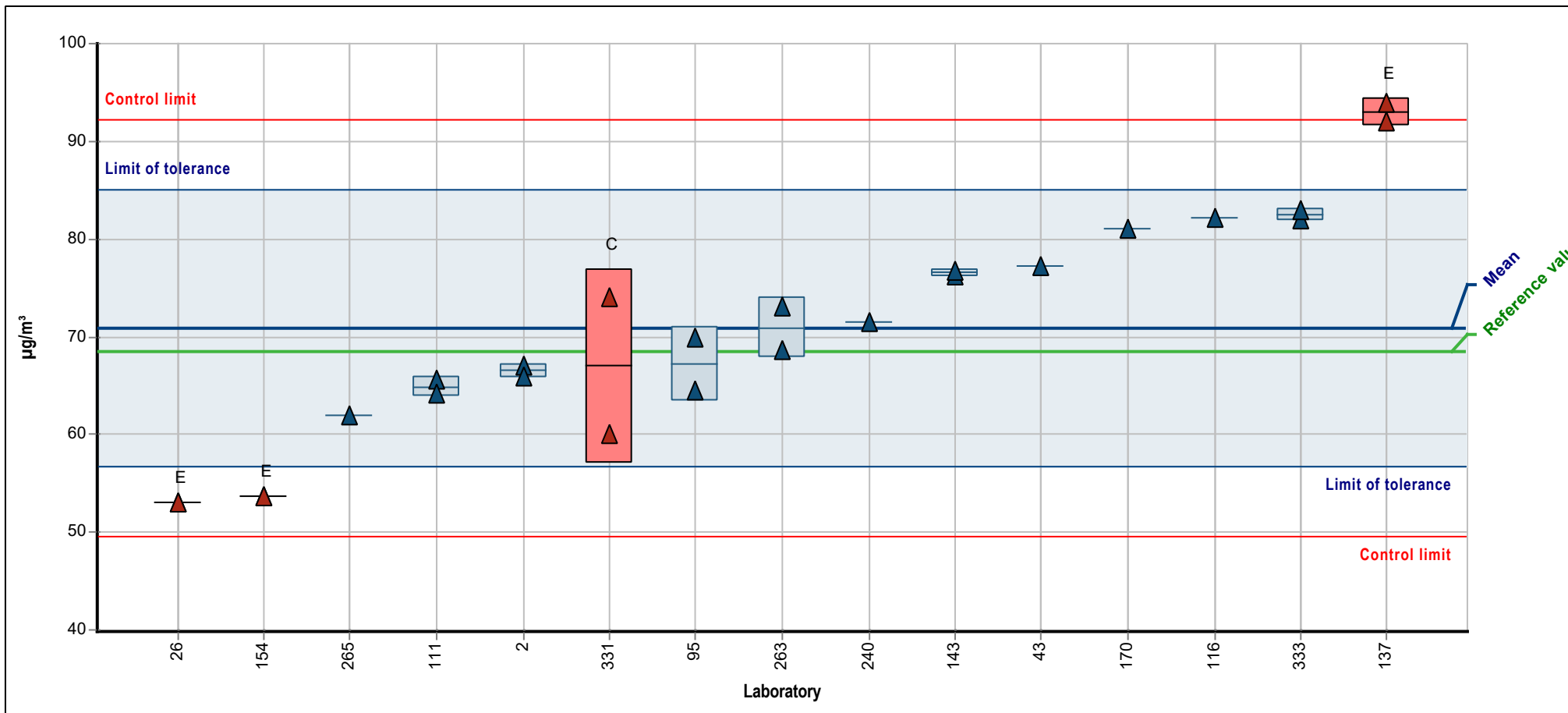


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
 Measurand: Naphtalene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 70.88 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 16.93%
 Reproducibility s.d.: 12.00 $\mu\text{g}/\text{m}^3$
 Reference value: 68.50 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 56.70 - 85.06 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 49.62 and 92.14 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

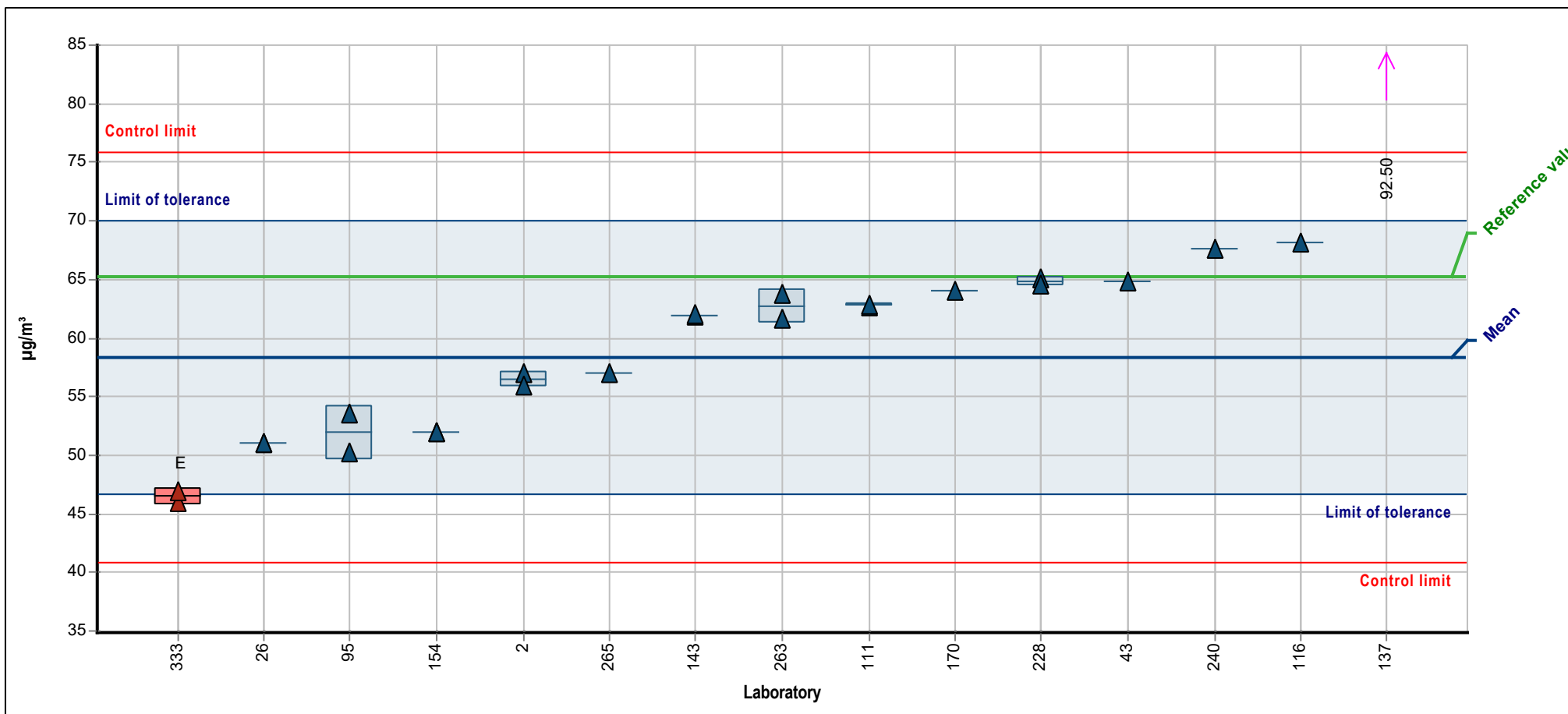


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
 Measurand: Toluene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 58.36 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 11.84%
 Reproducibility s.d.: 6.91 $\mu\text{g}/\text{m}^3$
 Reference value: 65.20 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 46.69 - 70.03 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 40.85 and 75.87 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

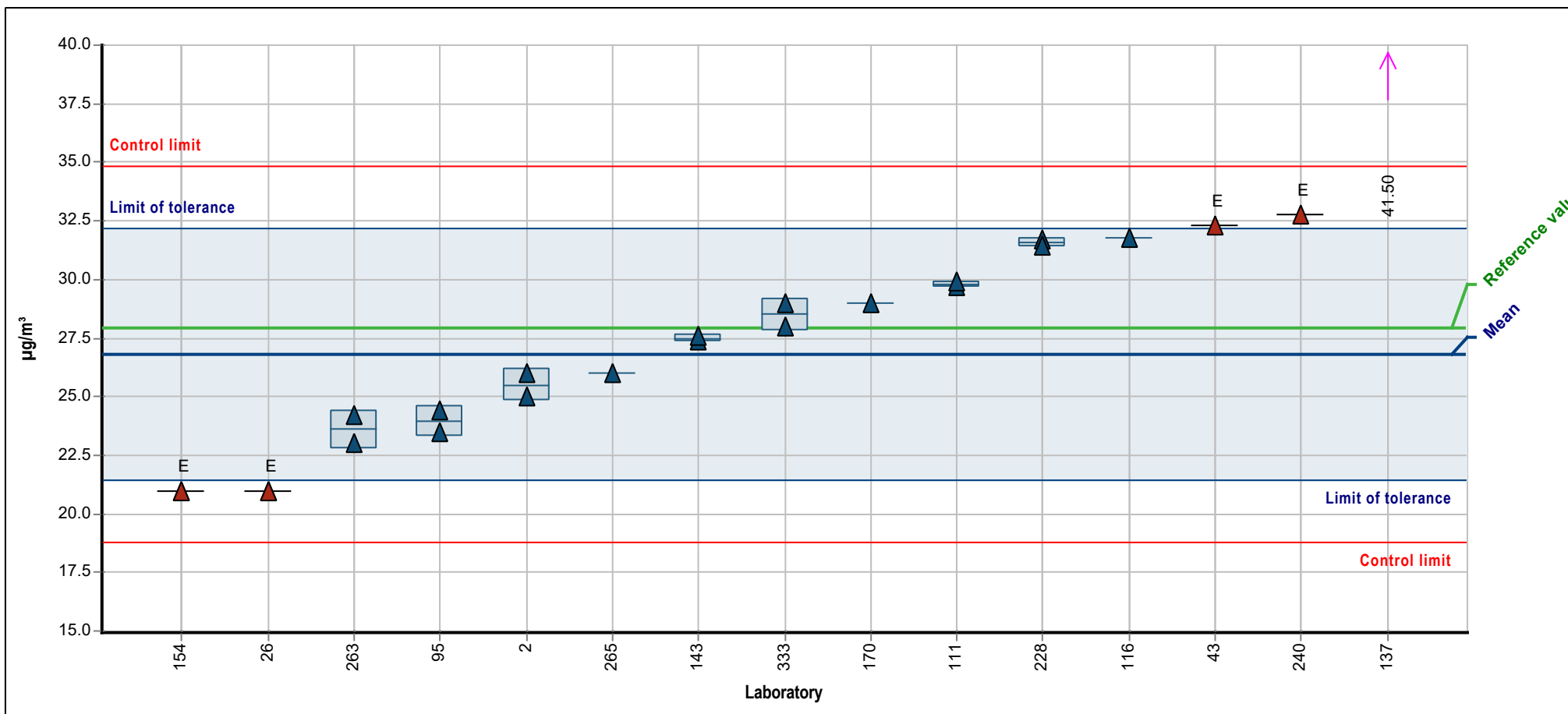


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

Sample: 2
 Measurand: 1,2,3-Trimethylbenzene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 26.81 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 15.01%
 Reproducibility s.d.: 4.02 $\mu\text{g}/\text{m}^3$
 Reference value: 27.90 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 21.45 - 32.18 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 18.77 and 34.86 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)

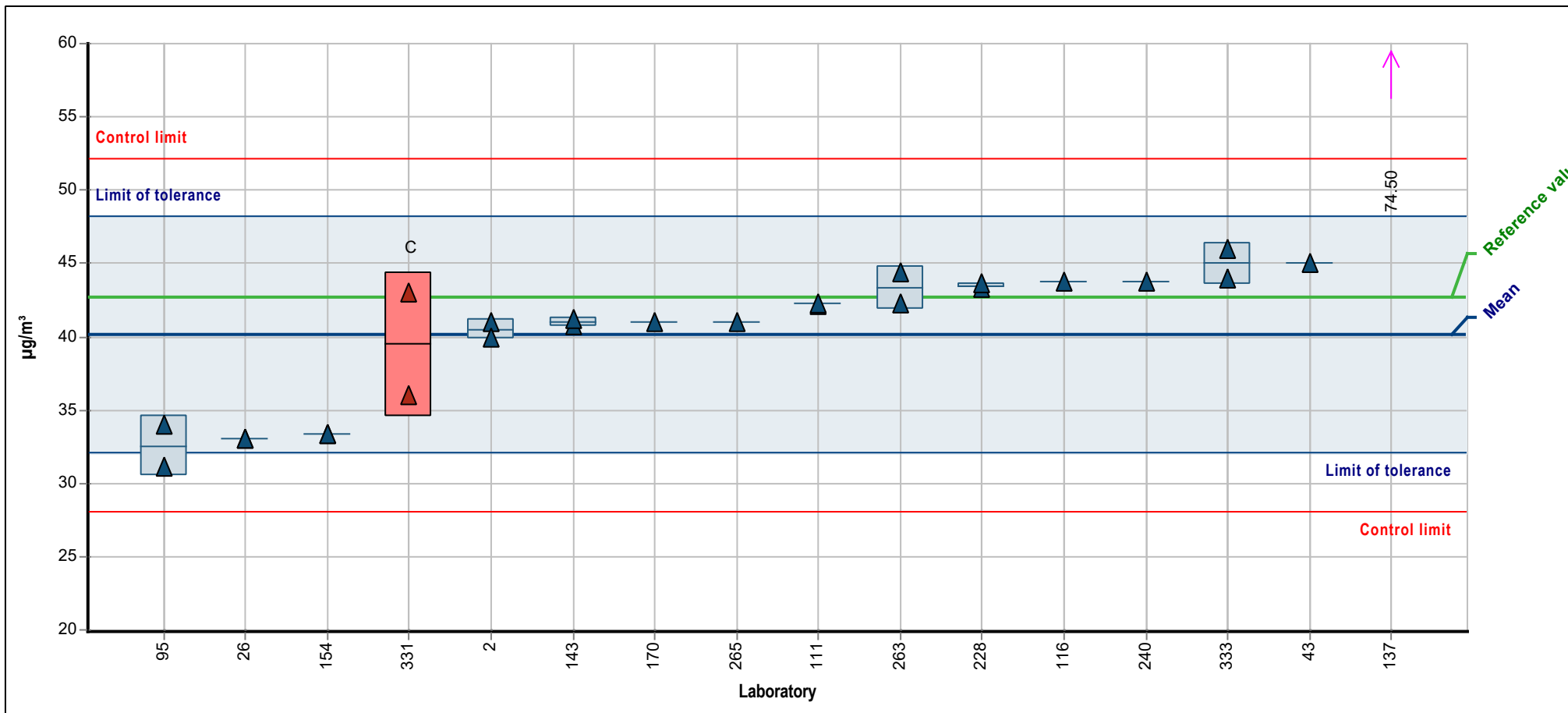


Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Summary results

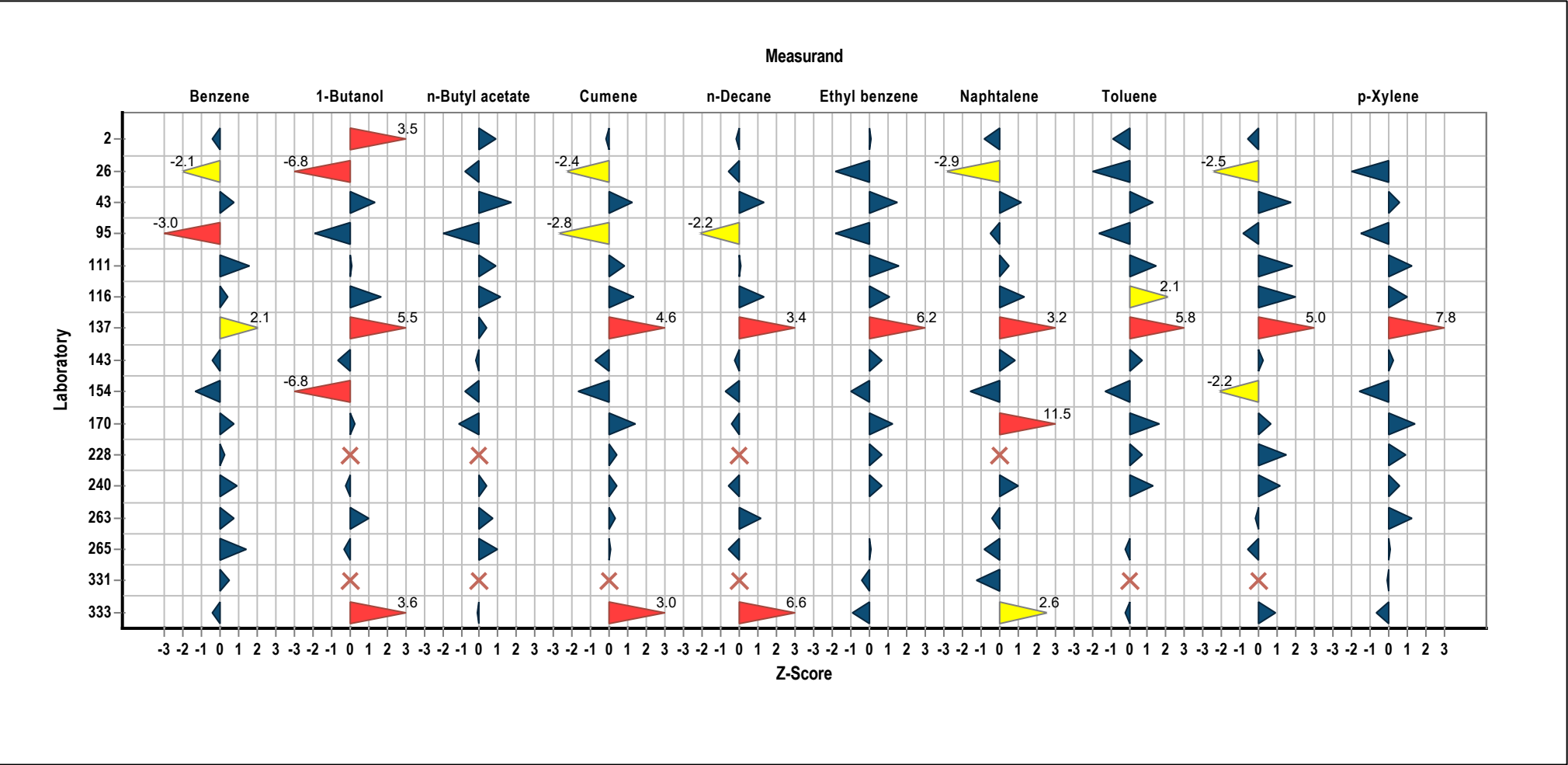
Sample: 2
 Measurand: p-Xylene
 Statistical method: ISO 5725-2
 Rel. SDPA: 10.00%
 Number of laboratories in calculation: 14

Mean: 40.15 $\mu\text{g}/\text{m}^3$
 Rel. reproducibility s.d.: 11.73%
 Reproducibility s.d.: 4.71 $\mu\text{g}/\text{m}^3$
 Reference value: 42.70 $\mu\text{g}/\text{m}^3$
 Range of tolerance: 32.12 - 48.18 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| \leq 2.00$)
 Control limits: 28.11 and 52.20 $\mu\text{g}/\text{m}^3$ ($|Z\text{-Score}| = 3.00$)



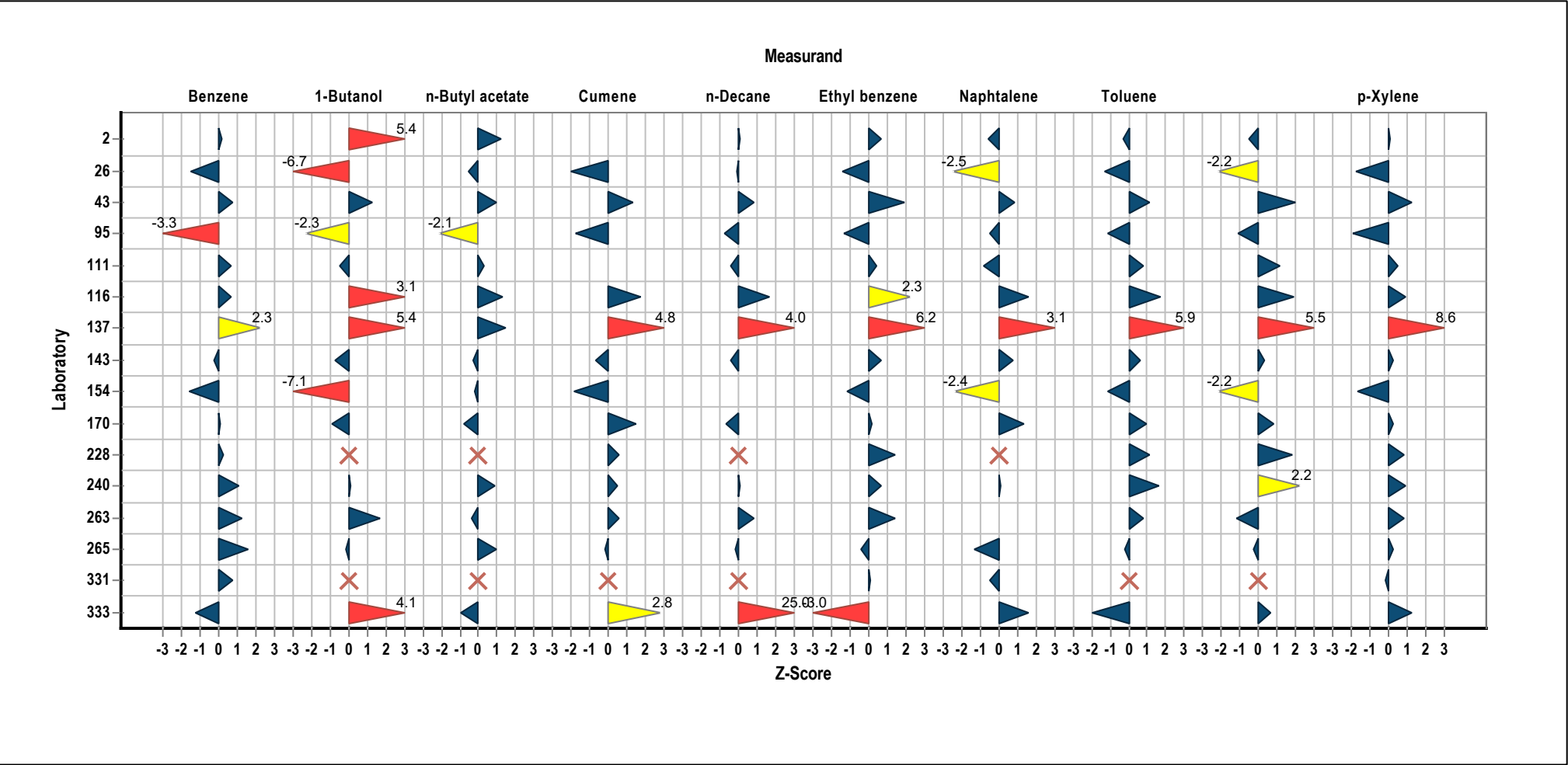
Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2
Sample chart of Z-Scores

Sample: 1



Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2
Sample chart of Z-Scores

Sample: 2



VOC with thermal desorption 2026 with own sampling 2 - blanc values

Sample blanc values

Summary of laboratory test results

Sample blanc values

	Benzene	1-Butanol	n-Butyl acetate	Cumene	n-Decane	Ethyl benzene	Naphtalene	Toluene	1,2,3-Trimethylbenzene	p-Xylene
Unit	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
2	< 0.90	< 0.90	< 0.90	< 0.90	< 0.90	< 0.90	< 0.90	< 0.90	< 0.90	< 0.90
43	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
95	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
111	0.23	0.53	0.14		0.14	0.04	0.01	0.31	0.01	0.03
116	< 0.50	3.30	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	3.10	< 0.50	0.50
137		1.00						4.00		
143	< 0.50	0.99	< 0.50	< 0.50	< 0.50	< 0.50	1.10	1.80		
170								3.00		
240	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
263	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
333	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
–	–	–	–	–	–	–	–	–	–	–
No. of laboratories that submitted results	9	10	9	8	9	9	9	11	8	8

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Questions and Answers

Participant	Sample carrier	Sampling pump	Flow rate sampling
2	Tenax Markes	Holbach Bivoc 2v2	0,1 L/min
26	Tenax in Edelstahlhülse	Gilian LFS	86ml/min
43	TENAX TA (Supelco)	BIVOC-2 (Fa. Holbach)	0,05 / 0,1 l/min
95	Tenax GR	GSA SG350ex	0,1 L/min
111	Tenax, Fa. Markes	GilAir	0,08 l/min
116	Tenax TA (Supelco)	Lfs113	0,33L/min
137	Tenax	Messwert 1= GilAir Plus S/N 20111030019, Messwert 2= BiVOC2/34V0034	0,1 L/min
143	Tenax TA, Markes	Gil Air+	0,2 l/min
154	Tenax in Edelstahlhülse	Gillian GilAir plus	86 ml/min
170			
228	Tenax	Hersteller Holbach Model BiVOC2	0.1 l/min
240	Tenax TA, 60/80 mesh, FA Supelco	Holbach BiVOC2	120 mL/min
263	Tenax TA Glas-Tube, Markes	GilAir Plus	0,1 l/min
265	Tenax TA	BiVOC V2, Holbach	0,1 L/min
331	TENAX, GRADKO	SKC	~55 ml/min
333	Tenax TA, Gerstel	GSA	0,14 l/min

Participant	Flow rate measurement	Sampling time	Analytical method
2		20min	DIN ISO 16000-6
26	Gilibrator 3 (Trockenzelle mit Graphitkolben)	30	DIN ISO 16000-6
43	BiVOC-2 (Fa. Holbach)	20 Minuten	DIN ISO 16000-6
95	DryCal DC Lite	30 min, 45 min, 60 min	DIN EN ISO 16000-6
111	BIOS Defender 510L	14 - 50 Minuten	DIN ISO 16000-06
116	Bios Defender	30 Minuten	DIN ISO 16000-6
137	Balgengaszähler (Gasuhr) 25 4234 0877	40 min	DIN ISO 16000-6:2022-03
143	Massenflussmesser Analyt MTC	10 min	DIN ISO 16000-6
154	Gilibrator 3 (Trockenzelle mit Graphitkolben)	30	DIN ISO 16000-6

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Questions and Answers

Participant	Flow rate measurement	Sampling time	Analytical method
228	Hersteller Holbach Model BiVOC2	20 Minuten	DIN ISO 16000-6
240	red-y compact series by vögtlin	15 Minuten	DIN ISO 16000-6
263	Interner Massendurchflusszähler (kalibriert, Umrechnung auf Betriebsvolumen)	30 min	DIN ISO 16000-6:2022-03
265	Massenflussmesser von Bronkhorst	20 min	DIN ISO 16000-6
331	MESA LABS, DEFENDER 520	90	16000-6
333		20	DIN EN ISO 16000-5 (2007-05)

Participant	Thermal desorber	Desorption temperature tube	Desorption flow	Desorption time	Cryotrap desorption temperature
26	Markes TD100XR	280°C	50	10	-25°C
43	ThermodesorberTD30R (Shimadzu)	250°C	60 ml/min	5 Minuten	-20°C
95	Gerstel TD3.5 +	270°C	40 mL/min	7 min	- 145°C
111	Shimadzu TD30-R	320 °C	60 ml/min	15	-18 °C
116	TD30R (Shimadzu)	250°C	60ml/min	5min	-20°C
137	Markes TD100-xr				
143	Markes TD 100-XT	250°C	20	20	-10°C
154	Markes TD100XR	280 °C	50 mL/min	10 Minuten	-25°C
228	Markes Unit 2	280°C	40 ml/min	7 Minuten	5°C
240	Shimadzu TD30-R	270 °C	60 mL/min	10 Minuten	- 20 °C
263	Markes TD100	285 °C	50 ml/min	10 min	5 °C
265	Shimadzu TD30	290 °C	60	15	-17 °C
331					
333	TDS 3, Gerstel	gradient from 40°C to 260°C	30.0 ml/min	5	-30°C

Participant	Cryotrap focusing temperature	Gas chromatograph (GC)	Carrier gas	Flow rate carrier gas
26	315°C	Agilent 7890B	Helium	0,5
43	250°C	GCMS-QP2020 (Shimadzu)	Helium	1,2 l/min
95	300 °C	Agilent 8890	Helium	0,8 mL/min
111	280°C	Shimadzu GC-2010	Helium	44,7 ml/min

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Questions and Answers

Participant	Cryotrap focusing temperature	Gas chromatograph (GC)	Carrier gas	Flow rate carrier gas
116	250°C	GCMS-QP2020 (Shimadzu)	Helium	1,2ml/min
137		SHIMADZU Nexis GC-20230	Helium	
143	300°C	Agilent 7820A	Helium	20
154	315 °C	Agilent 7890B	Helium	0,5mL/min
228	280°C	Agilent	Helium	1,3 ml/min
240	270 °C	Shimadzu GC-2010	Helium	1,86 mL/min
263	295 °C	Agilent 7890B	Helium	1,5 ml/min (constant flow)
265	290 °C	Shimadzu GC2030	Helium	2,46 ml/min
331				
333	280°C	Thermo Scientific GC Trace 1610	helium	0.6

Participant	Analytical Column	Detector
26	Rxi-5Sil MS 20m; ID: 0,18mm; Filmdicke: 0,36µm	MS 5977B
43	Rtx-5MS 30m, 0,25mmID, 1µmFD (Restek)	Massenspektrometer, FID
95	RTX-502.2; 40 m x 0,18 mm ID; 1µm FD	Agilent 5975C MSD
111	Rxi-5Sil MS GC Kapillarsäule, 60 m, 0.25 mm ID, 0.25 µm	MS Shimadzu QP-2010nc plus
116	Rtx-5MS 30m, 0,25mmID, 1µmFD (Restek)	Massenspektrometer, FID
137	OPTIMA 5 MS Accent MN	SHIMADZU GCMS-QP2020-NX
143	DB 624 UI	single quadrupol Agilent 5977 E MSD
154	Rxi-5Sil MS 20m; ID: 0,18mm; Filmdicke: 0,36µm	MS 5977B
228	HP Ultra 2	Agilent MS
240	SH-I-5MS (60m x 0.25 mm x 0.25 µm)	Shimadzu GCMS-QP2010Plus
263	DB-5 60 m x 0,25 mm x 0,5 µm	Agilent 5977
265	Agilent VF-5MS	MS
331		
333	Restek Rxi 1ms, 60m	MS

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Questions and Answers

Participant	Data evaluation
26	Quantifizierung über externen Kalibrierstandard, Identifizierung über Kalibrierung und NIST Datenbank
43	Identifizierung über Retentionszeit und Target/Qualifier, Kalibrierung substanzspezifisch, MS: interne Standardmethode, FID: externe Standardmethode
95	Quantifizierung über internen Standard, Identifizierung über MS-Spektrum und RT
111	interner Standard
116	Identifizierung über Retentionszeit und Target/Qualifier, Kalibrierung substanzspezifisch MS: interne Standardmethode, FID: externe Standardmethode
137	mit externen Standards
143	Kalibriergerade; Retentionszeiten und Massenspuren, interner Std
154	Quantifizierung über externen Kalibrierstandard, Identifizierung über Kalibrierung und NIST Datenbank
228	externer Standard
240	Quantifizierung durch externe 5 Punkt Kalibrierung
263	Scan mit m/z 35-350; Spektrenabgleich Kalibrierung + Datenbank über Qualifier-Ratios und Retentionszeit; interner Standard-Mix
265	über stoffspezifische Kalibration, interner Standard
331	
333	externe Referenz Standards

Participant	Recovery rates	Date of analysis
26	ja	24.06.26
43	Nein	30.06.2026
95	nein	25.06.-26.06.2026
111	nein	22.06.2026
116	nein	30.06.2026
137	nein	22.06.2026
143	nein	14.06.2026
154	ja	24.6.2026
228	nein	23.06.2026
240	nein	18.06.2026
263	Nein, nur interner Standard-Mix.	30.06.2026
265	nein	19.06.2026

Volatile organic compounds -VOC- with thermal desorption 2026 with own sampling 2

Questions and Answers

Participant	Recovery rates	Date of analysis
331	Nein	07.07.2026
333	nein	30.06.2026