IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

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

Proficiency testing scheme

Aldehydes 2025

in November

Institute for Occupationial Safety and Health of the
German Social Accident Insurance (IFA)
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Summary of laboratory test results

Sample 1

Laboratory	Butyraldehyde	Z score	Formaldehyde	Z score	Propionaldehyde	Z score
Unit	mg/m³		mg/m³		mg/m³	
9	0.970	-1.39	0.170	3.71 BE	0.280	2.53 E
13	1.220	0.83	0.125	0.08	0.238	0.65
22	0.904	-1.97	0.123	-0.08	0.198	-1.14
30	1.249	1.09	0.118	-0.48	0.224	0.02
42	1.215	0.79	0.124	0.00	0.237	0.61
45			0.043	-6.52 BE		
51	1.183	0.50	0.128	0.33	0.226	0.11
52			0.361	19.14 BE		
53	1.188	0.55	0.128	0.33	0.048	-7.85 BE
56	1.094	-0.29	0.114	-0.80	0.207	-0.74
60	1.272	1.29	0.135	0.85	0.244	0.94
62	1.030	-0.86	0.105	-1.53	0.202	-0.96
67			0.129	0.41	0.239	0.70
68	0.200	-8.22 BE	0.100	-1.93	0.200	-1.05
69			0.139	1.20	0.230	0.30
82			0.130	0.51		
83			0.130	0.49		
85	1.220	0.83	0.140	1.29	0.240	0.74
98	1.225	0.88	0.124	0.01	0.239	0.71
108	0.217	-8.07 BE	0.116	-0.64	1.161	41.96 BE
124	1.020	-0.94	0.120	-0.32	0.200	-1.05
132			0.121	-0.25	0.231	0.35
135	1.170	0.39	0.114	-0.80	0.226	0.11
141	1.010	-1.03	0.124	0.00	0.232	0.38
151			0.127	0.21		
167	1.139	0.11	0.112	-0.98	0.219	-0.18
182	1.060	-0.59	0.132	0.65	0.195	-1.27
186	1.183	0.50	0.113	-0.88	0.230	0.29
192	0.233	-7.93 BE	0.126	0.16	1.197	43.57 BE
207	1.072	-0.48	0.117	-0.56	0.218	-0.24
208	1.161	0.31	0.155	2.50 E	0.223	-0.02
211	1.173	0.41	0.120	-0.32	0.227	0.16
215	1.154	0.24	0.113	-0.90	0.219	-0.22
218	1.370	2.16 E	0.155	2.50 E	0.279	2.49 E
238	1.013	-1.01	0.123	-0.08	0.207	-0.74
248	1.199	0.64	0.120	-0.32	0.226	0.11
256	1.307	1.60	0.126	0.16	0.233	0.43
258	1.146	0.17	0.119	-0.40	0.219	-0.20
261	1.037	-0.79	0.117	-0.56	0.215	-0.38
264	0.930	-1.74	0.120	-0.32	0.220	-0.15
267	1.099	-0.25	0.123	-0.07	0.212	-0.51
303	1.030	-0.86	0.132	0.61	0.219	-0.21
306	1.192	0.59	0.141	1.37	0.224	0.03
308	1.100	-0.23	0.110	-1.13	0.200	-1.05
313	0.962	-1.46	0.120	-0.32	0.189	-1.54
–	–	– –	–	– –	–	– –
Method	ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	|Z|<=2.00		|Z|<=2.00		|Z|<=2.00	
No. of laboratories that submitted results	37		45		40	

Aldehydes 2025 — Sample 1

Laboratory	Butyraldehyde	Z score	Formaldehyde	Z score	Propionaldehyde	Z score
Mean	1.126		0.124		0.223	
Reprod. s.d.	0.111		0.011		0.020	
Rel. reproducibility s.d.	9.82 %		9.01 %		8.78 %	
Reference value	1.146		0.116		0.223	
Target s.d.	0.113		0.012		0.022	
Rel. target s.d.	10.00 %		10.00 %		10.00 %	
Low er limit of tolerance	0.901		0.099		0.179	
Upper limit of tolerance	1.352		0.149		0.268	
Type B outliers	3		3		3	
No. of measurement values outside of tolerance limits	4		5		5	
No. of laboratories after elimination of outliers type A-D and F (w ithout laboratories that only gave states but no measured values)	34		42		37	

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|>3.50	

Summary of laboratory test results

Sample 2

Laboratory	Formaldehyde	Z score	Propionaldehyde	Z score
Unit	mg/m³		mg/m³	
9	0.280	1.40	1.200	-0.61
13	0.267	0.87	1.390	0.88
22	0.256	0.43	1.164	-0.89
30	0.244	-0.06	1.231	-0.36
42	0.254	0.34	1.391	0.89
45	0.244	-0.05		
51	0.250	0.18	1.350	0.57
52	0.316	2.88 BE		
53	0.248	0.10	0.270	-7.89 BE
56	0.242	-0.14	1.222	-0.43
60	0.288	1.72	1.571	2.30 E
62	0.219	-1.08	1.177	-0.79
67	0.256	0.43	1.407	1.01
68	0.200	-1.85	1.210	-0.53
69	0.268	0.91	1.462	1.45
82	0.268	0.92		
83	0.240	-0.23		
85	0.260	0.59	1.360	0.65
98	0.255	0.39	1.365	0.69
108	0.227	-0.75	1.257	-0.16
124	0.220	-1.04	1.140	-1.08
132	0.251	0.24	1.339	0.48
135	0.237	-0.35	1.340	0.49
141	0.255	0.39	1.330	0.41
151	0.250	0.20		
167	0.231	-0.61	1.270	-0.06
182	0.259	0.55	1.080	-1.55
186	0.237	-0.35	1.346	0.54
192	0.243	-0.10	1.306	0.22
207	0.233	-0.51	1.219	-0.46
208	0.233	-0.51	1.271	-0.05
211	0.242	-0.14	1.300	0.18
215	0.223	-0.91	1.219	-0.46
218	0.308	2.54 BE	1.650	2.92 E
238	0.247	0.06	1.161	-0.91
248	0.249	0.14	1.320	0.33
256	0.244	-0.06	1.339	0.48
258	0.237	-0.35	1.259	-0.14
261	0.230	-0.63	1.234	-0.34
264	0.230	-0.63	1.200	-0.61
267	0.245	-0.03	1.204	-0.58
303	0.252	0.27	1.151	-0.99
306	0.274	1.14	1.193	-0.66
308	0.230	-0.63	1.200	-0.61
313	0.240	-0.23	0.993	-2.23 E
–	–	– –	–	– –
Method	ISO 5725-2		ISO 5725-2	
Assessment	|Z|<=2.00		|Z|<=2.00	
No. of laboratories that submitted results	45		40	

Laboratory	Formaldehyde	Z score	Propionaldehyde	Z score
Mean	0.246		1.277	
Reprod. s.d.	0.017		0.124	
Rel. reproducibility s.d.	6.90 %		9.71 %	
Reference value	0.227		1.289	
Target s.d.	0.025		0.128	
Rel. target s.d.	10.00 %		10.00 %	
Low er limit of tolerance	0.196		1.022	
Upper limit of tolerance	0.295		1.533	
Type B outliers	2		1	
No. of measurement values outside of tolerance limits	2		4	
No. of laboratories after elimination of outliers type A-D and F (w ithout laboratories that only gave states but no measured values)	43		39	
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|>3.50				

Summary of laboratory test results

Sample 3

Laboratory	Butyraldehyde	Z score	Formaldehyde	Z score
Unit	mg/m³		mg/m³	
9	0.160	-1.10	0.300	0.45
13	0.192	0.68	0.307	0.70
22	0.142	-2.10 E	0.294	0.24
30	0.201	1.19	0.287	0.00
42	0.196	0.91	0.299	0.42
45			0.106	-6.29 BE
51	0.187	0.41	0.292	0.17
52			0.150	-4.76 BE
53	0.189	0.52	0.298	0.38
56	0.172	-0.43	0.279	-0.28
60	0.201	1.19	0.312	0.88
62	0.162	-0.98	0.250	-1.29
67			0.304	0.59
68	0.200	1.13	0.250	-1.29
69			0.340	1.83
82			0.316	1.01
83			0.270	-0.59
85	0.190	0.57	0.310	0.80
98	0.194	0.77	0.299	0.44
108	0.174	-0.32	0.266	-0.73
124	0.170	-0.54	0.260	-0.94
132			0.292	0.18
135	0.189	0.52	0.274	-0.45
141	0.173	-0.37	0.301	0.49
151			0.243	-1.53
167	0.177	-0.16	0.271	-0.55
182	0.177	-0.15	0.304	0.59
186	0.185	0.30	0.281	-0.21
192	0.189	0.52	0.291	0.14
207	0.176	-0.21	0.273	-0.49
208	0.180	0.02	0.279	-0.28
211	0.183	0.18	0.282	-0.17
215	0.177	-0.13	0.264	-0.81
218	0.225	2.52 E	0.343	1.95
238	0.158	-1.21	0.286	-0.03
248	0.194	0.80	0.291	0.14
256	0.206	1.46	0.290	0.10
258	0.174	-0.32	0.274	-0.45
261	0.154	-1.43	0.265	-0.77
264	0.140	-2.21 E	0.270	-0.59
267	0.180	0.03	0.278	-0.31
303	0.170	-0.55	0.289	0.08
306	0.192	0.70	0.336	1.69
308	0.170	-0.54	0.250	-1.29
313	0.150	-1.65	0.280	-0.24
–	–	– –	–	– –
Method	ISO 5725-2		ISO 5725-2	
Assessment	|Z|<=2.00		|Z|<=2.00	
No. of laboratories that submitted results	37		45	

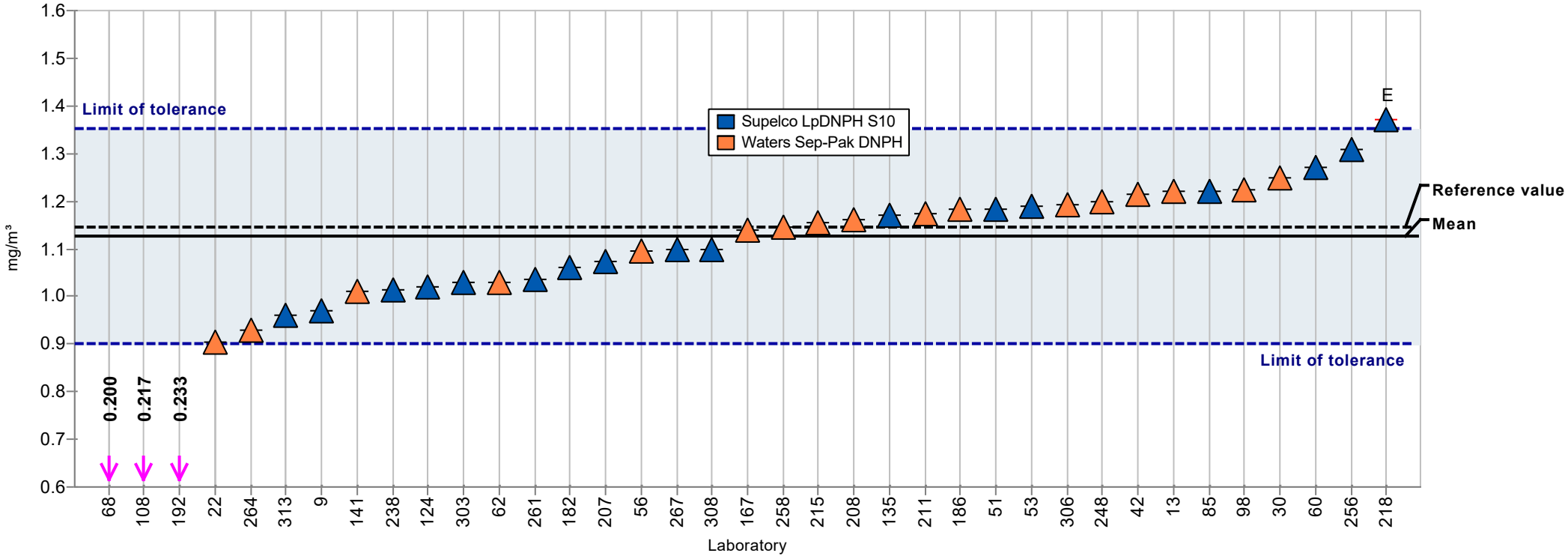
Aldehydes 2025 - not assessed

Sample 3

Laboratory	Butyraldehyde	Z score	Formaldehyde	Z score
Mean	0.180		0.287	
Reprod. s.d.	0.018		0.023	
Rel. reproducibility s.d.	10.03 %		7.99 %	
Reference value	0.181		0.266	
Target s.d.	0.018		0.029	
Rel. target s.d.	10.00 %		10.00 %	
Low er limit of tolerance	0.144		0.230	
Upper limit of tolerance	0.216		0.344	
Type B outliers			2	
No. of measurement values outside of tolerance limits	3		2	
No. of laboratories after elimination of outliers type A-D and F (w ithout laboratories that only gave states but no measured values)	37		43	
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|>3.50				

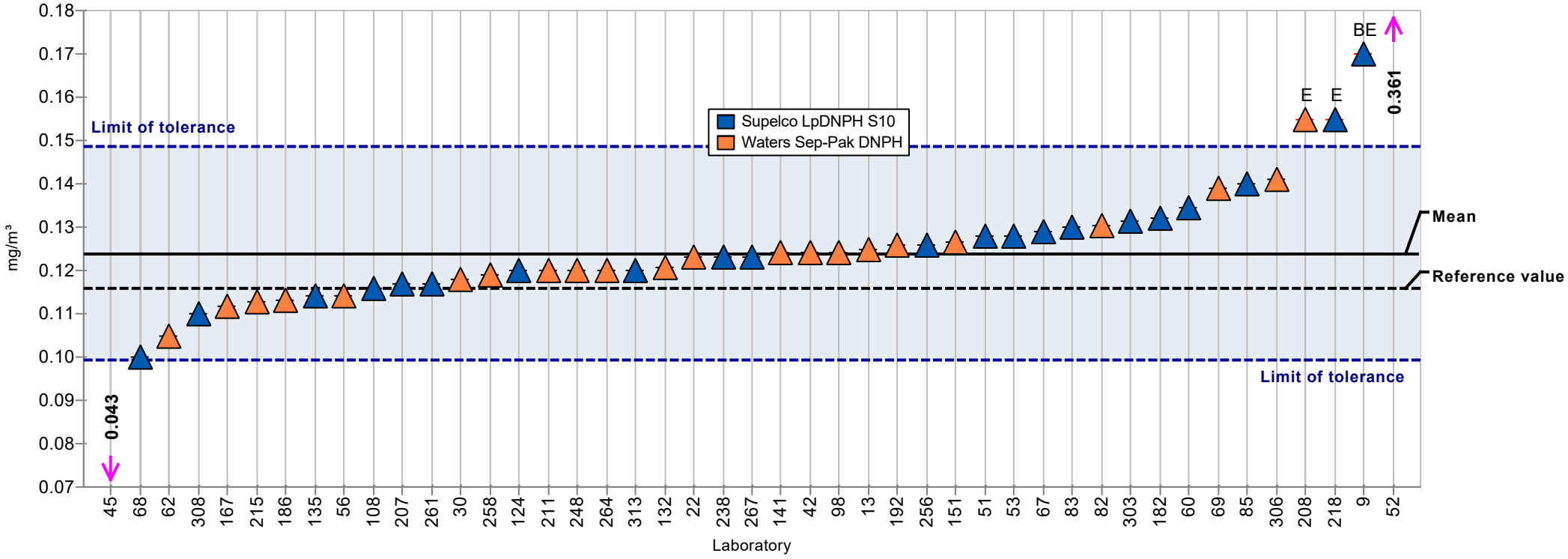
Summary results

Sample:	**1**	**Mean:**	**1.126 mg/m³**
Measurand:	**Butyraldehyde**	**Reprod. s.d.:**	**0.111 mg/m³**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**9.82%**
Rel.target s.d.:	**10.00%**	**Reference value:**	**1.146 mg/m³**
No. of laboratories:	**34**	**Range of tolerance:**	**0.901 - 1.352 mg/m³ (|Z-Score| <= 2.00)**
No. of outlier values:	**3**		



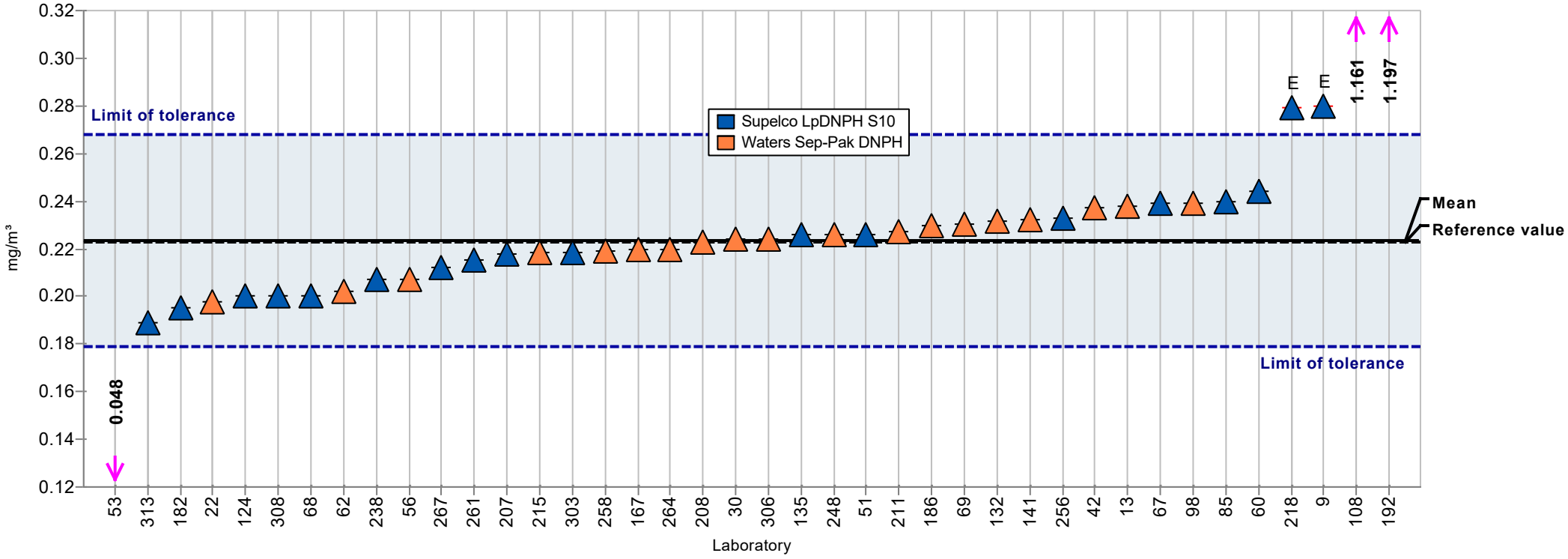
Summary results

Sample:	**1**	**Mean:**	**0.124 mg/m³**
Measurand:	**Formaldehyde**	**Reprod. s.d.:**	**0.011 mg/m³**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**9.01%**
Rel.target s.d.:	**10.00%**	**Reference value:**	**0.116 mg/m³**
No. of laboratories:	**42**	**Range of tolerance:**	**0.099 - 0.149 mg/m³ (|Z-Score| <= 2.00)**
No. of outlier values:	**3**		



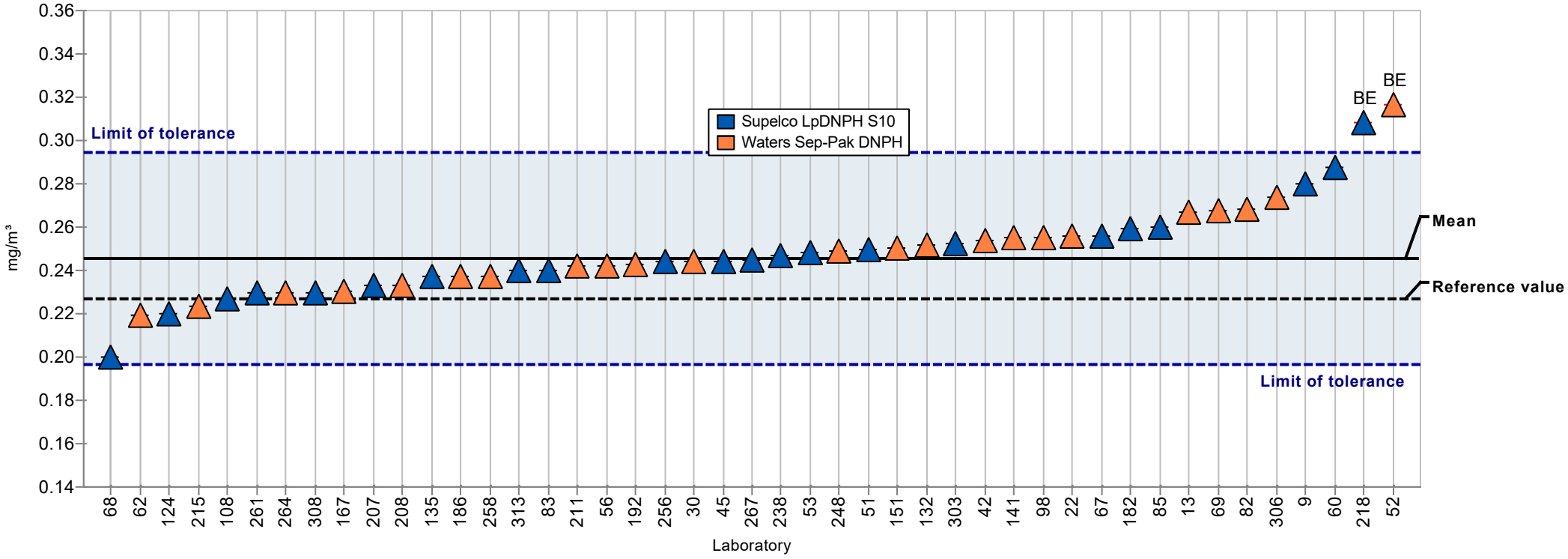
Summary results

Sample:	1	**Mean:**	0.223 mg/m³
Measurand:	Propionaldehyde	**Reprod. s.d.:**	0.020 mg/m³
Method:	ISO 5725-2	**Rel.reprod. s.d.:**	8.78%
Rel.target s.d.:	10.00%	**Reference value:**	0.223 mg/m³
No. of laboratories:	37	**Range of tolerance:**	0.179 - 0.268 mg/m³ (|Z-Score| <= 2.00)
No. of outlier values:	3		



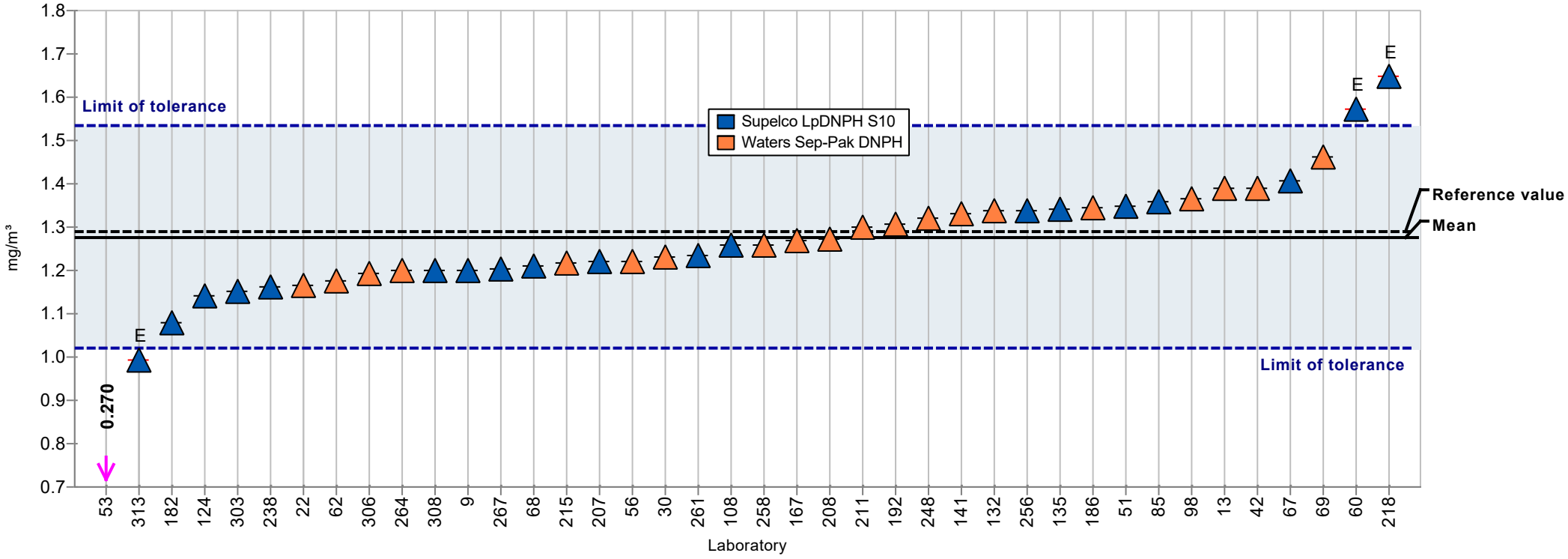
Summary results

Sample:	**2**	**Mean:**	**0.246 mg/m³**
Measurand:	**Formaldehyde**	**Reprod. s.d.:**	**0.017 mg/m³**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**6.90%**
Rel.target s.d.:	**10.00%**	**Reference value:**	**0.227 mg/m³**
No. of laboratories:	**43**	**Range of tolerance:**	**0.196 - 0.295 mg/m³ (|Z-Score| <= 2.00)**
No. of outlier values:	**2**		



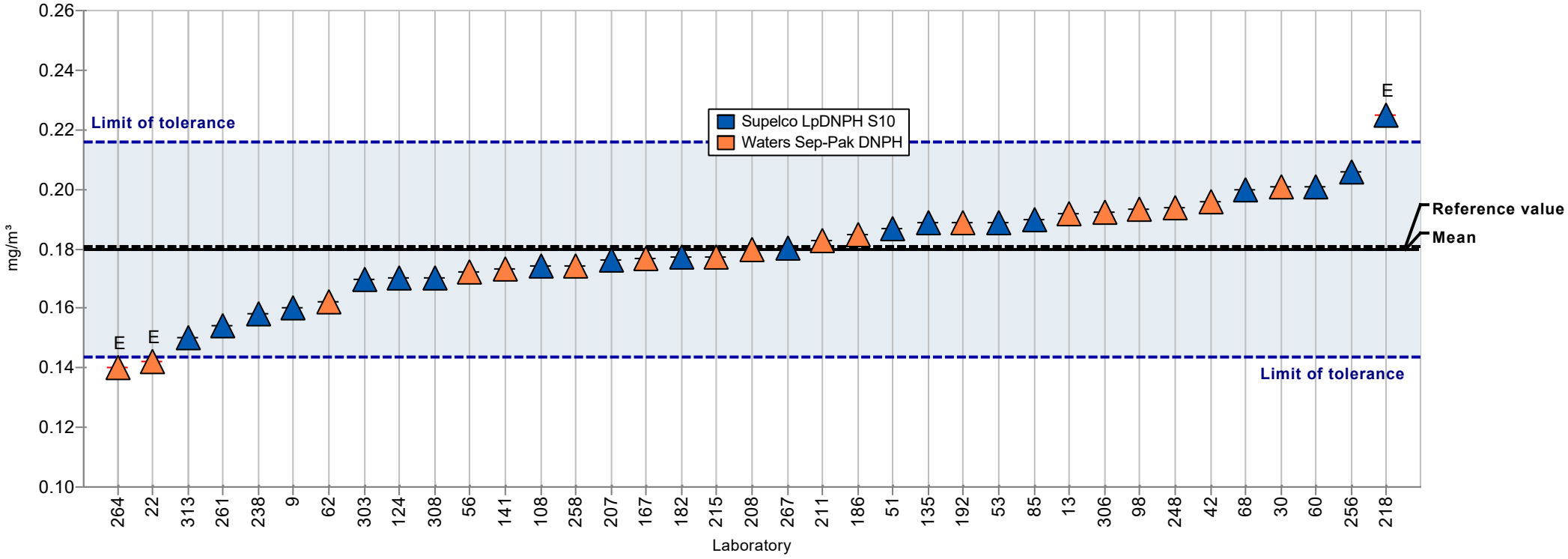
Summary results

Sample:	**2**	**Mean:**	**1.277 mg/m³**
Measurand:	**Propionaldehyde**	**Reprod. s.d.:**	**0.124 mg/m³**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**9.71%**
Rel.target s.d.:	**10.00%**	**Reference value:**	**1.289 mg/m³**
No. of laboratories:	**39**	**Range of tolerance:**	**1.022 - 1.533 mg/m³ (|Z-Score| <= 2.00)**
No. of outlier values:	**1**		



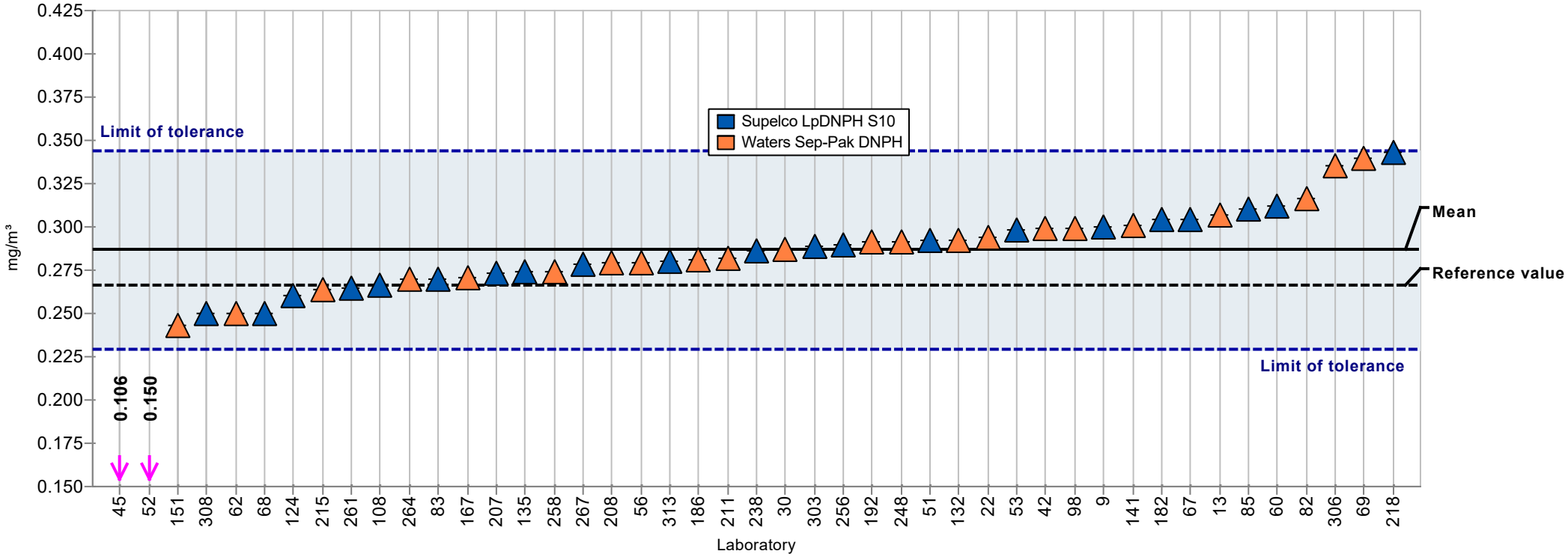
Summary results

Sample:	**3**	**Mean:**	**0.180 mg/m³**
Measurand:	**Butyraldehyde**	**Reprod. s.d.:**	**0.018 mg/m³**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**10.03%**
Rel.target s.d.:	**10.00%**	**Reference value:**	**0.181 mg/m³**
No. of laboratories:	**37**	**Range of tolerance:**	**0.144 - 0.216 mg/m³ (|Z-Score| <= 2.00)**
No. of outlier values:	**0**		



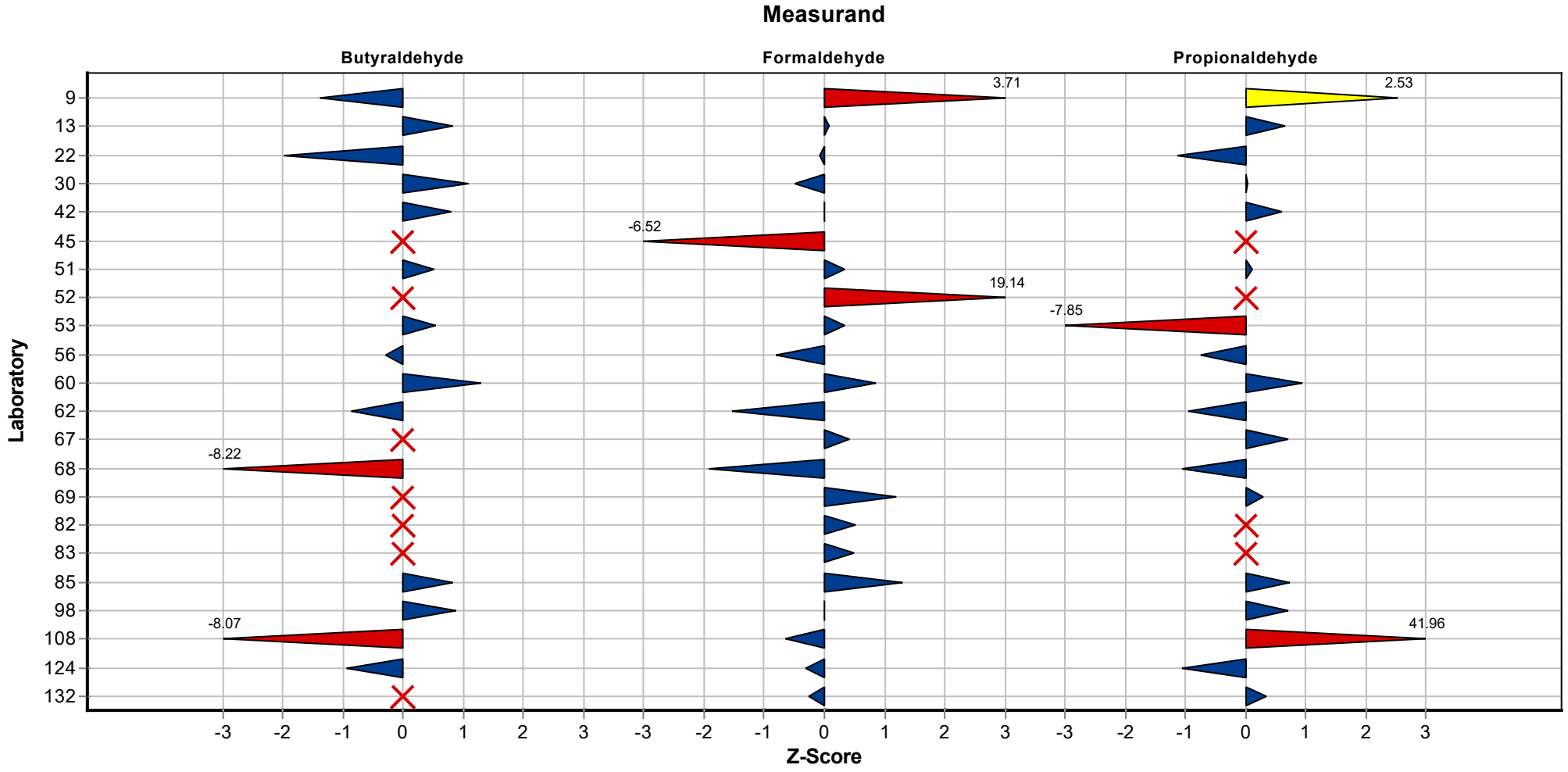
Summary results

Sample:	**3**	**Mean:**	**0.287 mg/m³**
Measurand:	**Formaldehyde**	**Reprod. s.d.:**	**0.023 mg/m³**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**7.99%**
Rel.target s.d.:	**10.00%**	**Reference value:**	**0.266 mg/m³**
No. of laboratories:	**43**	**Range of tolerance:**	**0.230 - 0.344 mg/m³ (|Z-Score| <= 2.00)**
No. of outlier values:	**2**		



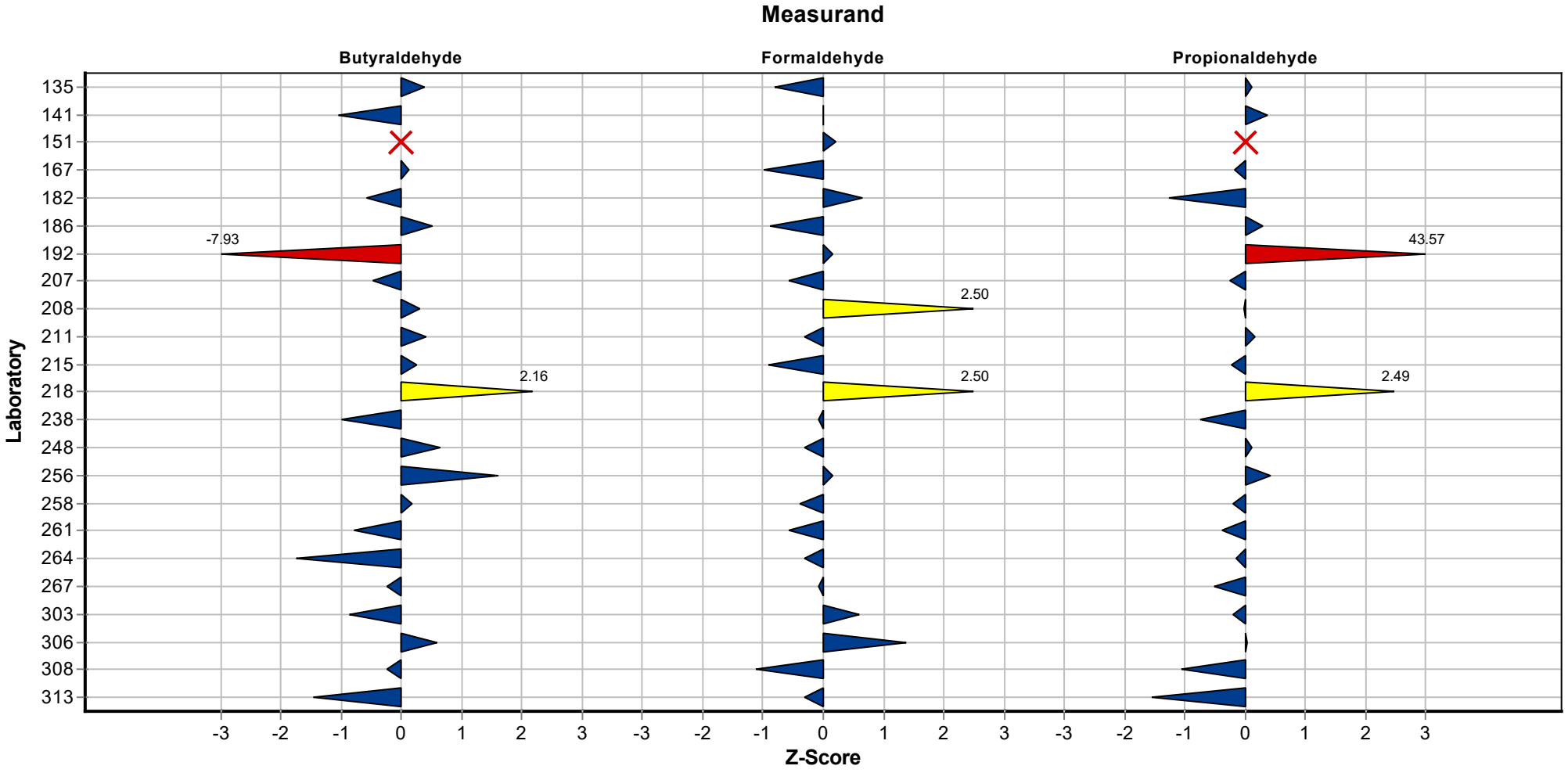
Sample chart of Z-scores

Sample 1



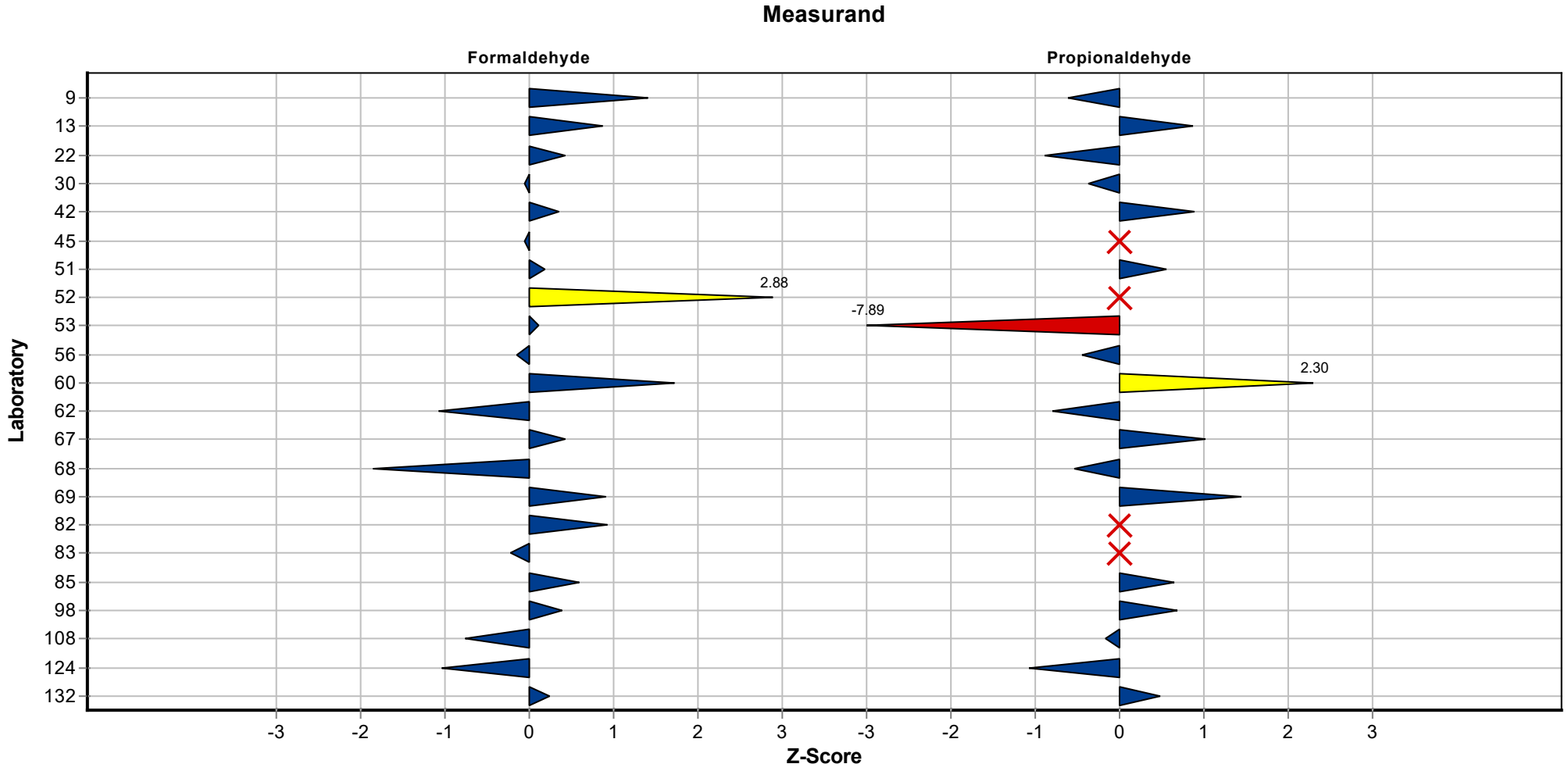
Sample chart of Z-scores

Sample 1



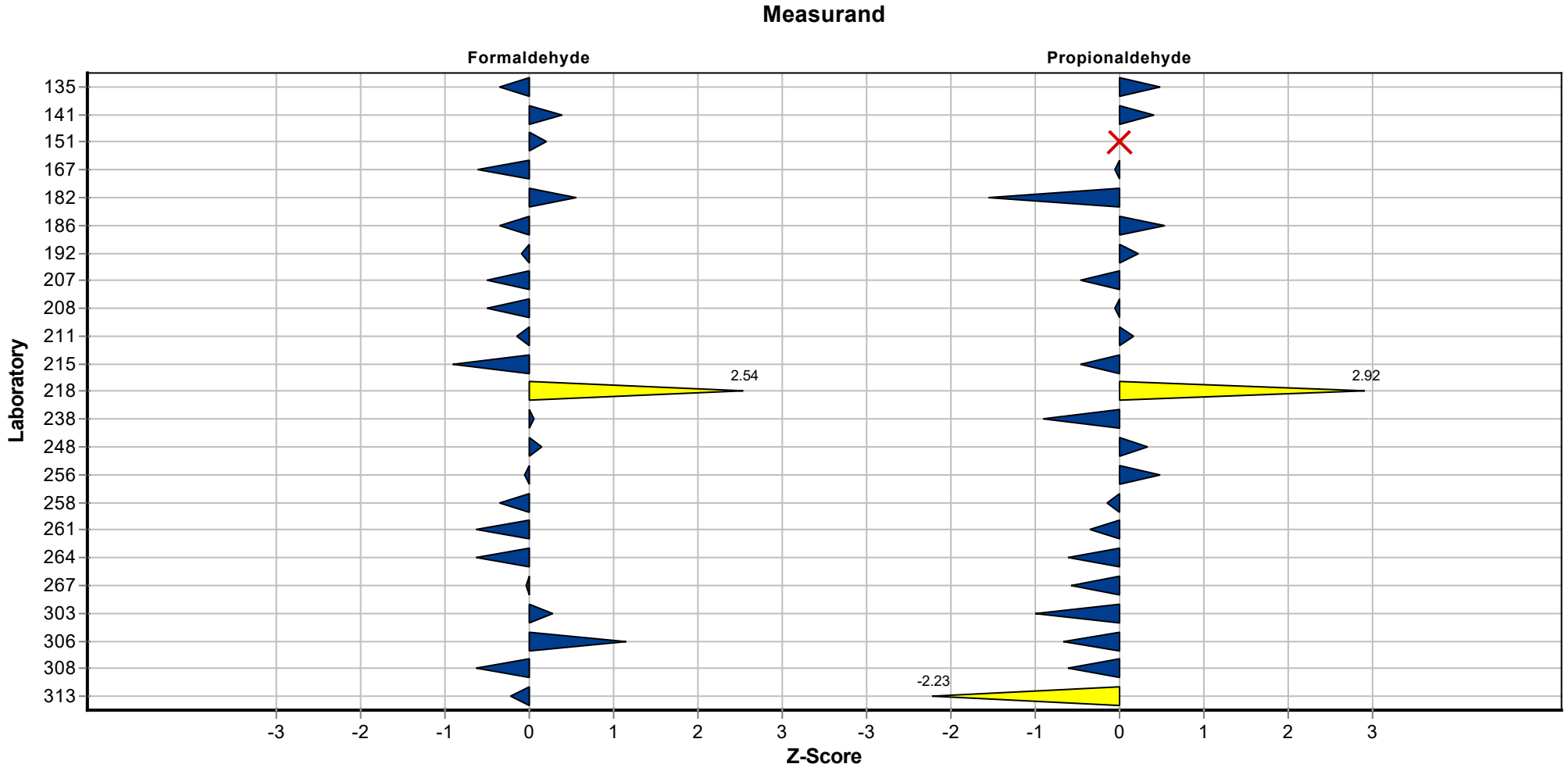
Sample chart of Z-scores

Sample 2



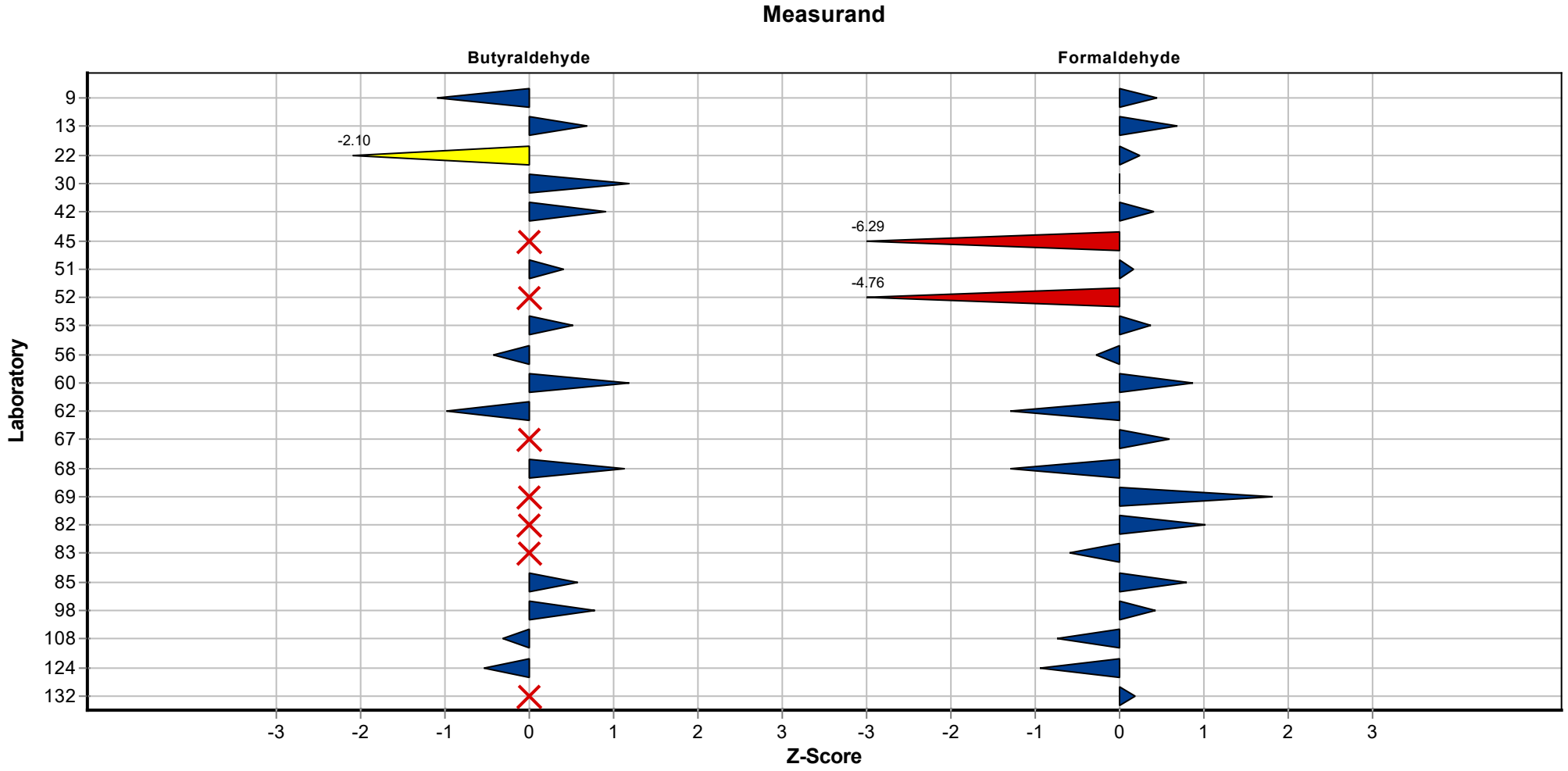
Sample chart of Z-scores

Sample 2



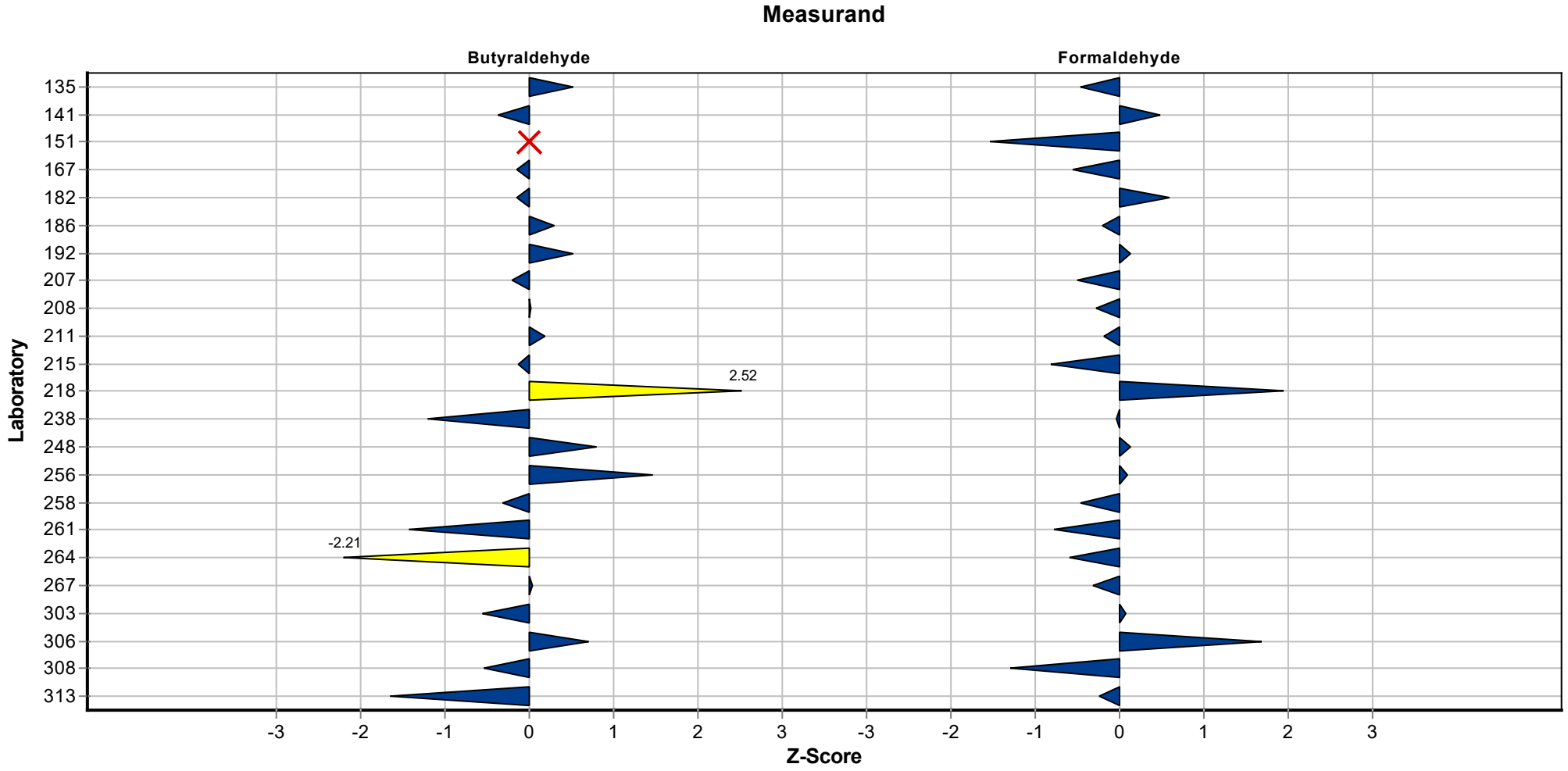
Sample chart of Z-scores

Sample 3



Sample chart of Z-scores

Sample 3



Questions and Answers

Participant	Analytical method	Start sample preparation
9	DIN ISO 16000-3:2011, aber mit ESI-MS/MS statt DAD.	04.12.2025
13	SOP-LCA-ALD cf ISO 16000-3 & NIOSH 2016	09/12/2025
22	Analysenmethode gemäß EN 16516 bzw . ISO 16000-3	17.11.2025
30	ISO 16000-3	14/11/2025
42	IFA Arbeitsmappe 6045	11.11.25
45	NIOSH 2016:2016	18/12/2025
51	Internal method derived from DIN ISO 16000-3	08/12/2025
52	HPLC	02.12.2025
53	in Anlehnung an Compendium Method TO-11A	11.11.2025
56	HPLC	06/11/2025
60	HPLC-DAD	12/11/2025
62	HPLC/UV	07/11/2025
67	NIOSH 2016:2016 and NIOSH 2018:2003	I started on November 3rd, 2025
68	IFA 6045	21.11.2025
69	HPLC	13/11/25
82	Hausmethode, sehr analog zur IFA 6045	10.11.2025
83	HPLC/DAD	20/11/2025
85	ISO16000-3:2022	14 November, 2025
98	analog IFA 6045 XI/09	3.-4.11.2025
108	DIN ISO 16000-3:2023-12	11.11.2025
124	HPLC, EPA TO-11A	12/4/2025
132	internal developed HPLC method	November 20-21, 2025
135	DIN ISO 16000-3	06.11.2025
141		
151	HPLC MDHS 102	16/12/2025
167	ISO 16000-3	26.Nov.2025
182	DIN EN ISO 16000-3: 2023-12	17.11.2025
186	NF ISO 16000-3	18/11/2025
192	ISO 16000-3	2025 Nov 12th
207	ISO 16000-3	07.11.2025
208	ISO 16000-3	11/12/2025
211	Hausinterne Prüfvorschrift 250 Stand: 26.09.2022	20.11.2025
215	DIN ISO 16000-3	14.11.25

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Participant	Analytical method	Start sample preparation
218	DIN ISO 16000-3:2023-12	14.11.2025
238	HPLC UV	07/11/2025
248	IFA 6045 (11-2007)	11.11.2025
256	In Anlehnung an EPA TO-11A	07.11.2025
258	ISO-16000-3	14-11-2025
261	DIN-ISO-16000-3_2022	06.11.2025
264	HPLC-UV	14/11/2025
267	ISO 16000-3	12/11/2025
303	ISO16000-3, but w ith mass spectrometer as detector	16/12 2025
306	ISO 18562-3 + ISO 16000-3	10/11/2025
308	HPLC-UV-DAD	10 November
313	Niosh 2016 2016 Niosh 2018 2003	11/11/2025

Participant	Storage time after desorption
9	Autosampler (4°C), Messung direkt nach Aufarbeitung.
13	Analysis took place immediately after desorption. Parts of the samples w ere stored in the refrigerator after desorption in case something w ent w rong during the analysis.
22	Die Messung erfolgte direkt nach der Desorption
30	48h - refrigerator
42	24h, Kühlschrank (8°C)
45	2 hour at room temperature
51	45 minutes - room temperature
52	Nein
53	nein, direkt analysiert
56	No storage, analysed just after desorption
60	no storage
62	1 day at 4°C
67	I desorbed on November 3rd, 2025 and i stored at 4 °C
68	1 Woche im KS
69	0 days
82	nein
83	No storage. Analyse after desorption.
85	No storage after desorption.
98	Proben w erden nicht eingefroren, sondern im Kühlschrank aufbew ahrt.
108	im Kühlschrank bei 4°C, gelagert bis zur Abgabe der Ergebnisse
124	1 day at RT
132	< 2 days. stored in refrigerator at 8°C

Proficiency testing scheme Aldehydes 2025

Participant	Storage time after desorption
135	nein
151	3 hours room temperature
167	30 min at room temp.
182	Probe w urde direkt nach der Desorption in den gekühlten Probengeber gegeben. Die Proben w erden 1 Monat lang im Kühlschrank gelagert.
186	no storage, analyses right after desorption
192	No storage after desorption
207	Gefrierschrank
208	-
211	Kühlschrank
215	ja, im Gefrierschrank bis zur Probenaufarbeitung
218	Kühlschrank
238	Immediately
248	Ja/2 Tage im Kühlschrank bei < 10°C
256	direkte Analyse
258	max. 2 hours, roomtemp.
261	4 °C
264	0 days / -18°C
267	Extracts analyzed directly after desorption (the same day), autosampler at room temperature
303	Just a few hours betw een desorption and completed analysis. Extracts w ere stored in refrigerator.
306	1 day in refrigerator
308	Samples w ere shipped w ithout cooling element and recieved at DTI 6 November and stored in refrigerator until 11 November
313	one day refrigerated at 4°C

Participant	Date of analysis	Desorption solution	Volume of desorption solution
9	04.12.2025	Acetonitril	5
13	09/12/2025	Acetonitrile	5 ml
22	17.11.2025	70% Acetonitril - 30% Milli-Q Wasser (v/v)	5 ml
30	16/11/2025	Acetonitrile	5
42	12.11.25	DNPH-Lösung	10ml
45	18/12/2025	acetonitrile	10
51	08-09/12/2025	CH3CN	5
52	02.12.2025	Acetonitril	5
53	11.11.2025	Acetonitril	5mL
56	06/11/2025	Acetonitril	5
60	12/11/2025	ACN	3
62	07/11/2025	acetonitrile	5ml

Proficiency testing scheme Aldehydes 2025

Participant	Date of analysis	Desorption solution	Volume of desorption solution
67	I desorbed and analyzed the samples on November 3rd, 2025	A solution of acetonitrile w as used	10 ml
68	27.11.2025	Acetonitril	10mL
69	13/11/25	Acetonitrile	5 ml
82	10.11.2025	Acetonitril	9,95
83	20/11/2025	acetonitrile	10
85	14 November, 2025	Acetonitrile	10ml
98	11.11.2025 und 21.11.2025	Acetonitril	10 ml
108	12.11.2025	Acetonitril	5
124	12/5/2025	MeCN	20 mL
132	November 20-21, 2025	acetonitrile	approximately 6 mL; volume w as w eighed
135	06.11.2025	Acetonitril	2 ml
151	16/12/2025	Acetonirile	3
167	26.Nov.2025	Acetonitrile	6 mL
182	17.11.2025	Acetonitril	3,1
186	18/11/2025	Acetonitrile	10
192	2025 Nov 12th, 13th	Acetonitrile	5mL
207	11.11.2025	ACN/H2O 60/40 + 5mmol (NH4)HCO3	5
208	11/12/2025	Acetonitrile	3
211	21.11.25	Acetonitril	10
215	14.11.25	ACN	5 ml
218	27.11.2025	Acetonitril	5
238	07/11/2025	Acetonitrile	5 mL
248	13.11.2025	Acetonitril	5
256	07.11.2025	ACN	2.5 ml
258	14-11-2025	acetonitrile	5
261	06.11.2025	Acetonitril	5 mL
264	14/11/2025	Acetonitrile	5mL
267	13/11/2025	Acetonitrile	5 mL
303	16/12 2025	Acetonitrile	5
306	11/11/2025	Acetonitrile	5 ml
308	11 November	Acetonitril	5 mL
313	11/11/2025	100% acetonitrile	10

Proficiency testing scheme Aldehydes 2025

Participant	Chromatography system	Refrigerated autosampler
9	Agilent 1290 Infinity Binary Pump, Sciex API 4000, Agilent 1290 Infinity Autosampler	Ja (4°C).
13	Agilent 1290 system w ith G7104A 1290 Flexible pump, G7117A 1290 DAD FS and G7167 B 1290 multisampler.	18°C
22	Thermo Fisher Pumpe LPG-3400SD, Ofen TCC-3000SD, Autosampler WPS-3000SL, DAD-3000	nein
30	Alliance e2695 / PDA 2998	no
42	Agilent Typ 1260 Infinity	nein
45	UV-VIS	yes, 10°C
51	Pump: Agilent 1260 Infinity II G7111B - Detector: Agilent UV 1260 Infinity II G7114A	No
52	Flexar PDA Plus	Nein
53	VWR 5160, VWR 5430 DAD, VWR 5260+ Thermostat	Ja, 30°C
56	PUMP VC-P20-A DIODE ARRAY DETECTOR FG VF-D11-A	Yes, 10°C
60	Agilent 1260 Quat Pump, 1260 DAD VL+	no
62	quaternary pump + UV detector	no, ambient temperature
67	I used a quaternary pump and UV/VIS/DAD detector	NO
68	HPLC-Anlage von Agilent 1260 Infinity LC System	Nein
69	Elite LabChrom Merck Hitachi, Pump L-2130 and Autosampler L.2200	No
82	Pumpe - Agilent Quat Pumpe G7111B, Detektor - DAD G7117C mit 6cm max Light Messzelle, Autosampler Agilent G7129A	nein
83		Yes.
85	LC-40D XR, SPD-M40 (Shimadzu)	Yes
98	Shimadzu HPLC-System LC-2030 Plus	nein
108	Pumpe A und B: Shimadzu LC-40D XR, Autosampler: Shimadzu SIL-40C XR, Detektor: Shimadzu UV Detector SPD-40	nein
124	Shimadzu LC-2050	no
132	HPLC quaternary pump w ith PDA detector	No
135	Agilent 1290 Infinity II	ja, 10°C
151	Thermo U3000, Waters SepPak	No
167	Waters e2695 HPLC	Room temp
186	quaternary pump and pda detector	Yes, 4°C
192	Agilent 1260 infinity ?	23?
207	Agilent 1260 Infinity LC DAD	-
208	Acquity H-class, PDA-detector	15 °C
211	Thermo Fischer Ulitimate 3000	ja, 10°C
215	Agilent 1290, Quat. Pumpe, DAD, HiP-Sampler	nein
238	quarternary pump + UV detector + autosampler Agilent 1260	No
248	Pumpe: LPG-3400SD / Detector: DAD-3000(RS) / FLD 3x00(RS) Autosampler: WPS-3000(RS)	nein
256	Agilent 1100 Series; Pumpe: G1311A, Quaternary Pump, Detektor: G1315B, Autosampler: G1313A	nein
258	Waters Acquity H-Class w ith UV-detector	No
261	Shimadzu LC-40D XR Solvent Delivery Pump, SPD-M40 PDA Detector, SIL-40 XR Autosampler	ohne Kühlung

Proficiency testing scheme Aldehydes 2025

Participant	Chromatography system	Refrigerated autosampler
264	Shimadzu	yes and yes
267	Agilent HPLC-DAD 1260	No, room temperature
303	Agilent 1290 Infinity system w ith G4220A pump, G4226A sampler and G6460A TripleQuadrupole detector	No, ambient temperature.
306	Agilent 1200 Series + Agilent 1200 Series DAD detector	no
308	HP1100 Agilent series	No
313	Shimadzu LC 20 series	SIL 20 refrigerated at 4°C

Participant	Analytical column
9	Phenomenex Kinetex 2.6 u C18 50 x 2.10 mm
13	Agilent Extend C18 4,6mm x 150mm 5µm
22	Thermo Scientific AcclaimTM Carbonyl C18
30	Restek Allure AK 4,6 mm 5 µm
42	Prontosil 120-5C 18 ace-EPS, 250x4,6 mm
45	SUPELCO LC18
51	J.T. Baker Octadecyl (C18) 250 x 4.6 - 5 µm
52	C18 Luna 250x4,6mm
53	Purospher® STAR RP-18e Hibar® RT 3µm 250-3
56	Acclaim RSLC Carbonyl 2.1*100 mm (Thermo)
60	Roc C18 5µm 150x4.6mm
62	Ascentis RP-Amide HPLC column
67	I used a ALLTECH-ALLTIMA C18 3µ particles, 150 mmx46 mm
68	Poroshell 120 EC-C18, 4.6 x 50 mm
69	Ascentis RP-Amide 25 cm x 4,6 mm
82	Agilent Poroshell 120 EC-C18, 100mm x 4,6mm, 2,7µm
83	Kinetex C18 150x4,6 mm 5µm
85	Shim-pack XR-ODS
98	LiChrospher 100RP18, 5 µm, 250×4 mm, Merck
108	Restek Raptor Biphenyl Säule 2.7µm 150 x 3.0mm
124	Restek Raptor 150x4.6 mm C-18 2.7 micron
132	Restek Allure AK 4.6x200mm, 5µm
135	M&N EC 250/4.6 NUCLOEDUR 100-5 C18 ec
151	Waters Acquity BEH C18 1.7µm 2.1*100 mm
167	Waters Symmetry C18 3,5 µm
186	ACQUITY UPLC BEH C18 1.7µm
192	Inertsil ODS-HL (5µm, 4.6 ×250nm)
207	Phenomenex Kinetex 2,6 µm 100 mm*4,6 mm

Proficiency testing scheme Aldehydes 2025

Participant	Analytical column
208	HSS C18 2,1x100mm; 1,8 µm
211	ACCLAIM CARBONYL COLUMN 3µM 2.1X150M
215	C18-Silica Trennsäule
238	SB C18
248	Acclaim™ RSLC Carbonyl 2.1 x 150mm - Acclaim™ RSLC Carbonyl 2.1 x 150mm Acclaim™ RSLC Carbonyl 2.1 x 150mm
256	Supelcosil LC-18, 25 cm x 4.6 mm, 5 µm
258	BEH C18, 2.1 x 50 mm, 1.7 µm
261	C18 (5UM, 25CM X 4.6MM, DISCOVERY, MERCK)
264	ACCLAIM RSLC Carbonyl 2.2 µm 100*3 mm
267	Waters Symmetry C18, 250 mm x 4.6 mm x 5 µm
303	Agilent Zorbax SB-C18 Narrow -Bore 2,1 x 150mm 3,5-Micron
306	Gemini 5um C18 110A 250 x 4.6 mm
308	Phenomenex Prodigy 5 µ ODS (3) 100 Å, (250 mm x3,2 mm x 5 µm)
313	Restek Raptor C18 5µm 150x4.6 mm

Participant	Mobile phase	Flow rate HPLC
9	Phase A: Wasser; Phase B: Acetonitril (jew eils + 0,1 % Ameisensäure)	0,5
13	Gradient composition milliQ:Acetonitrile	1,3 ml/min
22	12 min isokratisch bei 53% ACN und 47% Milli-Q Wasser, danach in 4,5 min lineare Konzentrationsänderung auf 100% ACN	0,6
30	Acetontrile / Water	1,2
42	A: 34Vol.% Acetonitril / 43 Vol.% H2O / 32 Vol.% Methanol; B: Acetonitril (Gradient)	1
45	acetonitrile / Water	1,3 ml/min
51	H2O/CH3CN	1.9
52	Acetonitril/Wasser 60/40	1
53	ACN/Wasser	0,65mL/min
56	H2O/ACN	0.450
60	70% ACN / 30% H2O	1
62	acetonitrile/w ater 40/60 => 75/25=> 100/0	1ml/min
67	Acetonitrile/w ater	0.6 ml/min
68	ACN/H2O (50/50)	1 ml/min
69	Acetonitrile-Water	1,5 ml/min
82	60/40 Wasser/ACN	1,0 ml/min
83	C18	1,2
85	Acetonitrile/H2O	0.4ml/min
98	Wasser - Acetonitril 51:49 bis 20:80	1,2
108	Eluent A: 50/50 MeOH/H2O, Eluent B: 100% MeOH	0,55

Proficiency testing scheme Aldehydes 2025

Participant	Mobile phase	Flow rate HPLC
124	MeCN/MeOH/w ater gradient	0.8
132	acetonitrile and w ater	1.2 mL/min
135	Acetonitril, Wasser, THF	2,3 ml/min
151	60:40 H2O:Acetonitrile	0.5
167	AcN w ith 0,1% phosphoric acid	1,5 mL/min
186	Acetonitrile, w ater and THF	0.6
192	Water / Acetonitrile	1.2mL/min
207	H2O/ACN/THF Gradient	1,5
208	ACN/THF/H2O	0.42
211	Wasser/Acetonitril	0,6 ml/min
215	Gradientenmethode mit THF/ACN/H2O	1 ml/min
238	Water / Acetonitrile	1.4 mL / min
248	H2O / ACN - 48% / 52%	0,4
256	Startbedingungen: 30% ACN, 60% Wasser, 10% THF	2.3 ml/min, ab 9.1 Minuten 2 ml/min
258	w ater/acetonitrile	0.8
261	Acetonitril und Wasser im Gradienten	1 ml/min
264	Buffer and Acetonitrile	1mL/min
267	Acetonitrile/Water	1.5 mL/min
303	Gradient as in ISO16000-3 (Water/Acetonitrile w ithout additives, Initial composition 65% w ater, 35% Acetonitrile)	0,3
306	Water and Acetonitrile	1.1 ml/min
308	Acetonitril, Methanol og Milli-Q-w ater - gradient program	0.5 mL/min.
313	Phase a 100% w ater phase B methanol/acetonitrile 650:50	0.7

Participant	Wavelength	Column temperature
9	Entfällt, da MS/MS (ESI) genutzt.	30 °C
13	360 nm	40°C
22	360 nm	28 °C
30	360	30°C
42	365 nm	23°C
45	360 nm	30
51	365 nm	25 °C
52	360	25 °C
53	355nm	35
56	360 m	30°C
60	360	30°C
62	360nm	30°C

Participant	Wavelength	Column temperature
67	I used 360 nm w avelenght	28 °C
68	360 nm	35°C
69	UV-visible 360 nm	40 ºC
82	354 nm	20,0°C
83	360 nm	40°C
85	360nm	40 C
98	365 nm	25°C
108	360 nm	43°C
124	360 nm	35oC
132	350 nm for formaldehyde 360 nm for acetaldehyde and propionaldehyde	30°C
135	365 nm	50°C
151	355	50°C
167	360 nm	40 °C
186	360nm	35°C
192	360nm	40?
207	360 nm	30°C
208	360 nm	40 °C
211	360 nm	28°C
215	360 nm	40 °C
238	365 nm	35°C
248	360 nm	28 °C
256	360 nm	25 °C
258	367 nm	40 °C
261	353 nm (Formaldehyd), 362 nm (Acetaldehyd), 364 nm (Propionaldehyd)	37 °C
264	360nm	30°C
267	365 nm	25 °C
303	Not applicable, as w e use a mass spectrometer.	30°C
306	360 nm	Room temperature
308	360 nm	28 degree Celcius
313	365 nm	35

Participant	Recovery rate
9	Nein.
13	YES
22	nein
30	No

Proficiency testing scheme Aldehydes 2025

Participant	Recovery rate
42	nein
45	no
51	Yes
52	Nein
53	nein
56	no
60	no
62	no
67	No, my result didn't include recovery rates
68	Formaldehyd 96.42%, Acetaldehyd 96.53%, Propionaldehyd 94.12%, Butyraldehyd 91.45%
69	No
82	Ja
83	No
85	No
98	nein
108	nein
124	no
132	no
135	nein
151	No
167	Yes
186	No
192	No
207	-
208	No
211	nein
215	nein
238	No
248	nein
256	nein
258	No
261	nein
264	no
267	No
303	No, but the cartridges w ere desorbed w ith a second volume of acetonitrile. The second extract had no content of any of the analytes, so I assume that the recovery rate w as 100% in the first desorbtion.

Proficiency testing scheme Aldehydes 2025

Participant	Recovery rate
306	no
308	No
313	no

Summary of laboratory test results

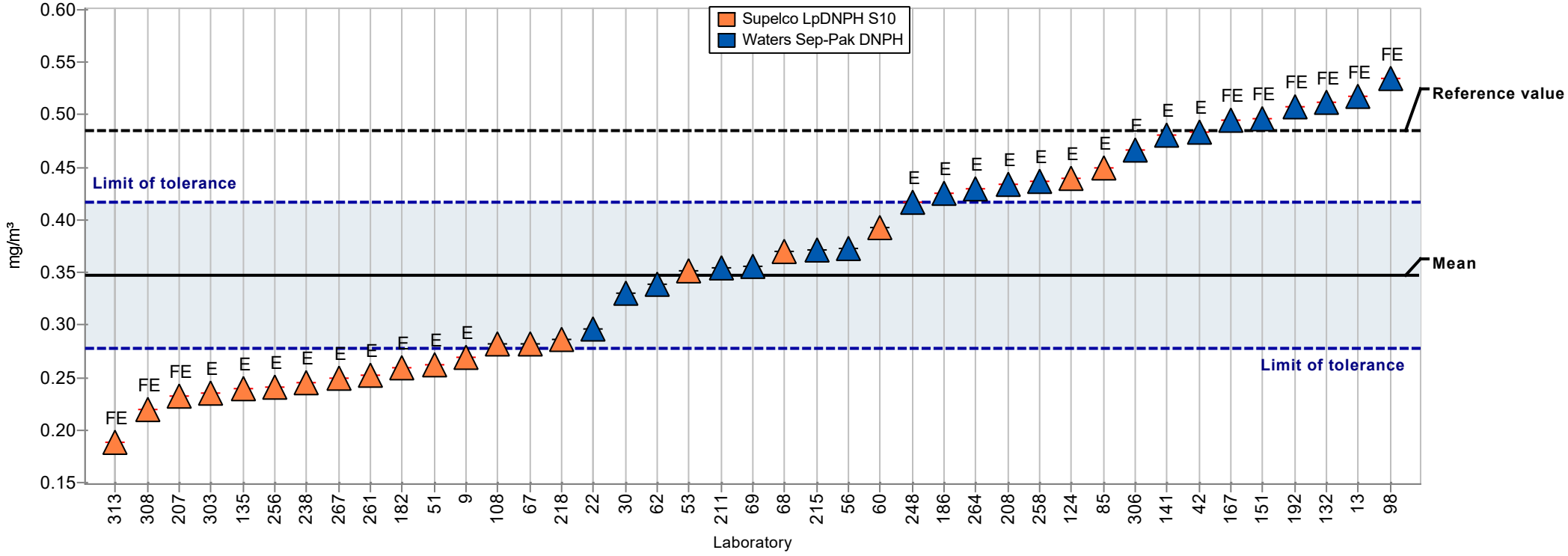
Measurand Acetaldehyde

Laboratory	Sample 1	Z score		Z score		Z score	
Unit	mg/m³			mg/m³		mg/m³	
9	0.270	-2.22	E	0.360	-3.27	E	0.730	-3.85	FE
13	0.517	4.90	FE	0.769	4.37	FE	1.670	4.07	FE
22	0.296	-1.47		0.474	-1.14		1.071	-0.98	
30	0.331	-0.46		0.520	-0.28		1.168	-0.16	
42	0.483	3.92	E	0.742	3.87	FE	1.732	4.59	FE
51	0.262	-2.45	E	0.467	-1.27		1.005	-1.53	
53	0.351	0.12		0.580	0.84		1.385	1.67	
56	0.373	0.75		0.578	0.80		1.323	1.15	
60	0.392	1.31		0.718	3.43	E	1.421	1.97	
62	0.339	-0.23		0.537	0.04		1.179	-0.07	
67	0.282	-1.87		0.457	-1.46		1.023	-1.38	
68	0.370	0.66		0.550	0.28		1.290	0.87	
69	0.355	0.24		0.513	-0.41		1.281	0.80	
85	0.450	2.97	E	0.680	2.71	E	1.350	1.37	
98	0.534	5.40	FE	0.779	4.55	FE	1.735	4.62	FE
108	0.282	-1.87		0.419	-2.17	E	0.829	-3.02	E
124	0.440	2.68	E	0.630	1.77		1.430	2.05	E
132	0.512	4.75	FE	0.762	4.23	FE	1.688	4.23	FE
135	0.240	-3.08	E	0.353	-3.40	E	0.750	-3.68	FE
141	0.481	3.86	E	0.715	3.36	E	1.620	3.65	FE
151	0.495	4.28	FE	0.625	1.69		1.455	2.26	E
167	0.494	4.24	FE	0.721	3.47	E	1.628	3.72	FE
182	0.260	-2.51	E	0.383	-2.84	E	0.804	-3.23	E
186	0.426	2.28	E	0.635	1.87		1.438	2.12	E
192	0.508	4.64	FE	0.723	3.51	E	1.672	4.09	FE
207	0.233	-3.28	FE	0.352	-3.42	E	0.721	-3.93	FE
208	0.434	2.51	E	0.593	1.08		1.346	1.34	
211	0.354	0.20		0.521	-0.26		1.162	-0.21	
215	0.371	0.69		0.519	-0.29		1.206	0.16	
218	0.287	-1.73		0.445	-1.68		0.902	-2.40	E
238	0.246	-2.91	E	0.367	-3.14	E	0.817	-3.12	E
248	0.417	2.02	E	0.625	1.68		1.392	1.73	
256	0.241	-3.05	E	0.341	-3.63	FE	0.743	-3.74	FE
258	0.437	2.59	E	0.589	1.01		1.319	1.11	
261	0.252	-2.74	E	0.368	-3.12	E	0.775	-3.47	E
264	0.430	2.39	E	0.620	1.59		1.400	1.80	
267	0.249	-2.82	E	0.383	-2.84	E	0.776	-3.46	E
303	0.235	-3.21	E	0.346	-3.53	FE	0.698	-4.12	FE
306	0.466	3.43	E	0.636	1.89		1.498	2.62	E
308	0.220	-3.66	FE	0.330	-3.83	FE	0.710	-4.02	FE
313	0.189	-4.55	FE	0.276	-4.84	FE	0.570	-5.20	FE
–	–	–	–	–	–	–	–	–	–
Method	ISO 5725-2			ISO 5725-2			ISO 5725-2		
Assessment	|Z|<=2.00			|Z|<=2.00			|Z|<=2.00		
No. of laboratories that submitted results	41			41			41		
Mean	0.347			0.535			1.187		
Reprod. s.d.	0.082			0.119			0.239		

Laboratory	Sample 1	Z score	Sample 2	Z score	Sample 3	Z score
Rel. reproducibility s.d.	23.56 %		22.33 %		20.14 %	
Reference value	0.485		0.724		1.626	
Target s.d.	0.035		0.054		0.119	
Rel. target s.d.	10.00 %		10.00 %		10.00 %	
Low er limit of tolerance	0.278		0.428		0.949	
Upper limit of tolerance	0.416		0.642		1.424	
No. of measurement values outside of tolerance limits	28		21		24	
Type F outliers	9		8		14	
No. of laboratories after elimination of outliers type A-D and F (w ithout laboratories that only gave states but no measured values)	32		33		27	
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|>3.50						

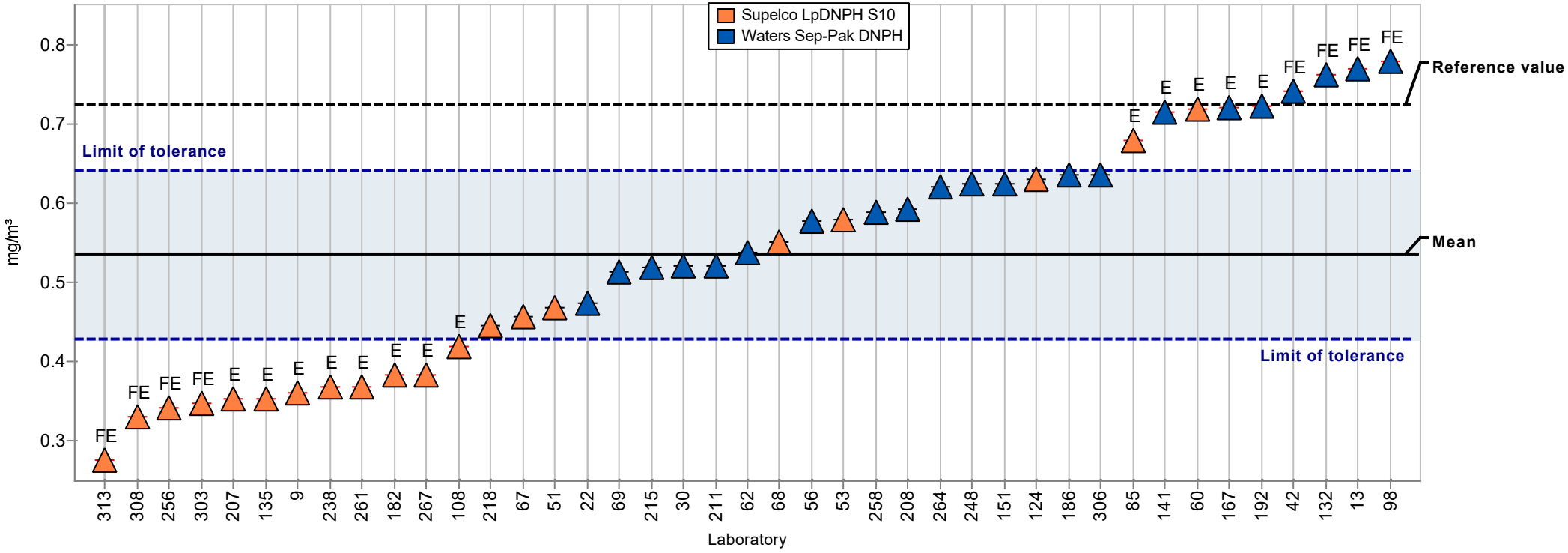
Summary results

Sample:	**1**	**Mean:**	**0.347 mg/m³**
Measurand:	**Acetaldehyde**	**Reprod. s.d.:**	**0.082 mg/m³**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**23.56%**
Rel.target s.d.:	**10.00%**	**Reference value:**	**0.485 mg/m³**
No. of laboratories:	**41**	**Range of tolerance:**	**0.278 - 0.416 mg/m³ (|Z-Score| <= 2.00)**
No. of outlier values:	**9**		



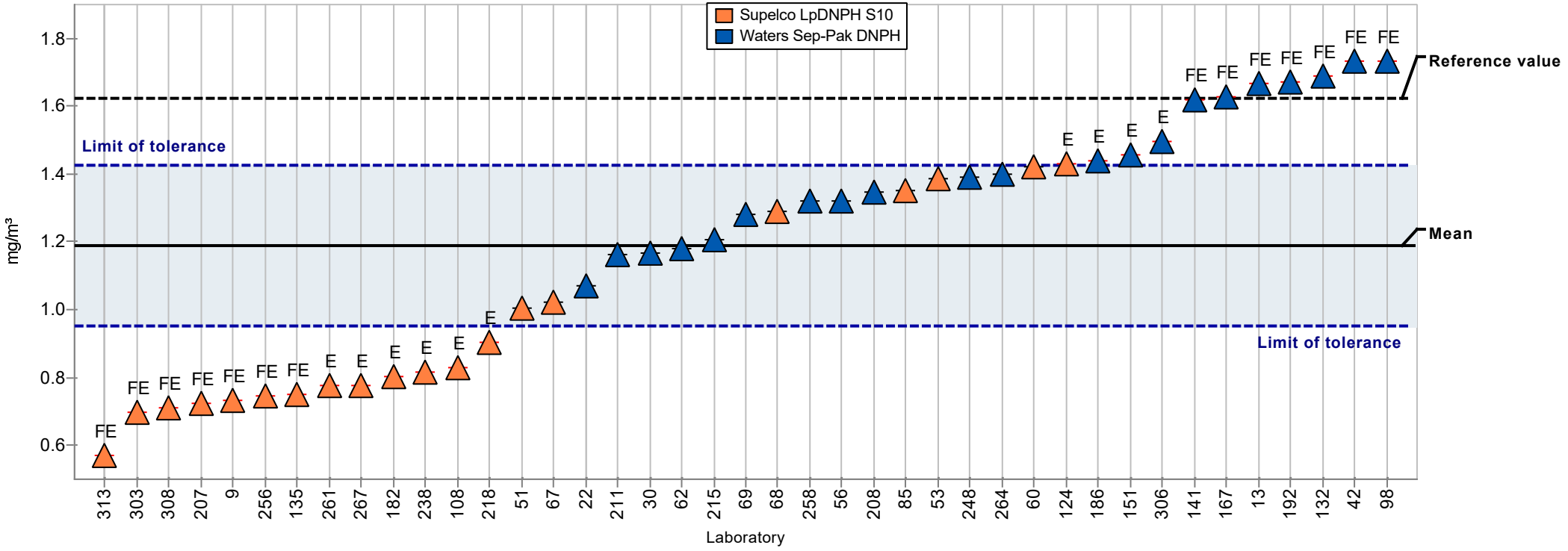
Summary results

Sample:	**2**	**Mean:**	**0.535 mg/m³**
Measurand:	**Acetaldehyde**	**Reprod. s.d.:**	**0.119 mg/m³**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**22.33%**
Rel.target s.d.:	**10.00%**	**Reference value:**	**0.724 mg/m³**
No. of laboratories:	**41**	**Range of tolerance:**	**0.428 - 0.642 mg/m³ (|Z-Score| <= 2.00)**
No. of outlier values:	**8**		



Summary results

Sample:	3	**Mean:**	1.187 mg/m³
Measurand:	Acetaldehyde	**Reprod. s.d.:**	0.239 mg/m³
Method:	ISO 5725-2	**Rel.reprod. s.d.:**	20.14%
Rel.target s.d.:	10.00%	**Reference value:**	1.626 mg/m³
No. of laboratories:	41	**Range of tolerance:**	0.949 - 1.424 mg/m³ (|Z-Score| <= 2.00)
No. of outlier values:	14		



Test on equivalence

Recovery rate equivalence

		Sample 1	Sample 2	Sample 3	Across all samples
Waters Sep-Pak DNPH	No. of laboratories	21	21	21	
Waters Sep-Pak DNPH	Mean	0.432 mg/m³	0.628 mg/m³	1.428 mg/m³	
Waters Sep-Pak DNPH	Reproducibility s.d.	17.98%	16.46%	16.79%	
Waters Sep-Pak DNPH	Repeatability s.d.				
Waters Sep-Pak DNPH	Standard error	4.02%	3.68%	3.76%	
Supelco LpDNPH S10	No. of laboratories	20	20	20	
Supelco LpDNPH S10	Mean	0.269 mg/m³	0.415 mg/m³	0.868 mg/m³	
Supelco LpDNPH S10	Reproducibility s.d.	17.26%	20.16%	19.18%	
Supelco LpDNPH S10	Repeatability s.d.				
Supelco LpDNPH S10	Standard error	3.96%	4.62%	4.40%	
Level of significance		5.0 %	5.0 %	5.0 %	5.0 %
t-test	t value	8.005	7.109	8.506	12.460
t-test	Critical value	1.960	1.960	1.960	1.960
Test on equivalence	Maximal tolerated theoretical difference	+/- 10.0 %	+/- 10.0 %	+/- 10.0 %	+/- 10.0 %
Test on equivalence	Maximal tolerated empirical deviation	+/- 2.44%	+/- 2.36%	+/- 2.56%	+/- 5.48%
Test on equivalence	Empirical deviation	-37.77%	-34.01%	-39.23%	-37.01%
Test decision		**not equivalent**	**not equivalent**	**not equivalent**	**not equivalent**

Test on equivalence

Recovery rate equivalence

		Sample 1	Sample 3	Across all samples
Waters Sep-Pak DNPH	No. of laboratories	18	18	
Waters Sep-Pak DNPH	Mean	1.141 mg/m³	0.181 mg/m³	
Waters Sep-Pak DNPH	Reproducibility s.d.	8.00%	8.61%	
Waters Sep-Pak DNPH	Repeatability s.d.			
Waters Sep-Pak DNPH	Standard error	1.93%	2.08%	
Supelco LpDNPH S10	No. of laboratories	19	19	
Supelco LpDNPH S10	Mean	1.121 mg/m³	0.180 mg/m³	
Supelco LpDNPH S10	Reproducibility s.d.	13.98%	12.35%	
Supelco LpDNPH S10	Repeatability s.d.			
Supelco LpDNPH S10	Standard error	3.29%	2.91%	
Level of significance		5.0 %	5.0 %	5.0 %
t-test	t value	0.465	0.186	0.488
t-test	Critical value	2.045	1.960	1.960
Test on equivalence	Maximal tolerated theoretical difference	+/- 10.0 %	+/- 10.0 %	+/- 10.0 %
Test on equivalence	Maximal tolerated empirical deviation	+/- 3.77%	+/- 4.09%	+/- 5.63%
Test on equivalence	Empirical deviation	-1.75%	-0.66%	-1.21%
Test decision		**equivalent in the strict sense**	**equivalent in the strict sense**	**equivalent in the strict sense**

Test on equivalence

Recovery rate equivalence

		Sample 1	Sample 2	Sample 3	Across all samples
Waters Sep-Pak DNPH	No. of laboratories	23	23	23	
Waters Sep-Pak DNPH	Mean	0.122 mg/m³	0.248 mg/m³	0.288 mg/m³	
Waters Sep-Pak DNPH	Reproducibility s.d.	8.16%	7.82%	8.67%	
Waters Sep-Pak DNPH	Repeatability s.d.				
Waters Sep-Pak DNPH	Standard error	1.75%	1.67%	1.86%	
Supelco LpDNPH S10	No. of laboratories	22	22	22	
Supelco LpDNPH S10	Mean	0.125 mg/m³	0.245 mg/m³	0.285 mg/m³	
Supelco LpDNPH S10	Reproducibility s.d.	10.37%	7.96%	9.24%	
Supelco LpDNPH S10	Repeatability s.d.				
Supelco LpDNPH S10	Standard error	2.27%	1.74%	2.02%	
Level of significance		5.0 %	5.0 %	5.0 %	5.0 %
t-test	t value	0.834	0.369	0.396	0.224
t-test	Critical value	1.960	1.960	1.960	1.960
Test on equivalence	Maximal tolerated theoretical difference	+/- 10.0 %	+/- 10.0 %	+/- 10.0 %	+/- 10.0 %
Test on equivalence	Maximal tolerated empirical deviation	+/- 5.11%	+/- 5.84%	+/- 5.37%	+/- 7.26%
Test on equivalence	Empirical deviation	2.42%	-0.89%	-1.08%	0.15%
Test decision		**equivalent in the strict sense**	**equivalent in the strict sense**	**equivalent in the strict sense**	**equivalent in the strict sense**

Test on equivalence

Recovery rate equivalence

		Sample 1	Sample 2	Across all samples
Waters Sep-Pak DNPH	No. of laboratories	20	20	
Waters Sep-Pak DNPH	Mean	0.224 mg/m³	1.286 mg/m³	
Waters Sep-Pak DNPH	Reproducibility s.d.	5.68%	7.08%	
Waters Sep-Pak DNPH	Repeatability s.d.			
Waters Sep-Pak DNPH	Standard error	1.30%	1.62%	
Supelco LpDNPH S10	No. of laboratories	20	20	
Supelco LpDNPH S10	Mean	0.222 mg/m³	1.255 mg/m³	
Supelco LpDNPH S10	Reproducibility s.d.	13.67%	12.12%	
Supelco LpDNPH S10	Repeatability s.d.			
Supelco LpDNPH S10	Standard error	3.14%	2.78%	
Level of significance		5.0 %	5.0 %	5.0 %
t-test	t value	0.245	0.756	0.788
t-test	Critical value	2.060	1.960	1.960
Test on equivalence	Maximal tolerated theoretical difference	+/- 10.0 %	+/- 10.0 %	+/- 10.0 %
Test on equivalence	Maximal tolerated empirical deviation	+/- 4.39%	+/- 4.71%	+/- 6.07%
Test on equivalence	Empirical deviation	-0.82%	-2.39%	-1.61%
Test decision		**equivalent in the strict sense**	**equivalent in the strict sense**	**equivalent in the strict sense**

Homogeneity test

Overview of statistical values and results

Sample description	Measurand description	Unit	Mean	s(analytical) [%]	s(sample) [%]	Mode for SDPA	HORRAT	SDPA [%]	Replicates	Test items
Sample 1	Acetaldehyde	mg/m3	0.485	0.49	0.52	Manual	1	10.00	2	10
Sample 1	Butyraldehyde	mg/m3	1.146	0.35	0.61	Manual	1	10.00	2	10
Sample 1	Formaldehyde	mg/m3	0.116	0.67	0.88	Manual	1	10.00	2	10
Sample 1	Propionaldehyde	mg/m3	0.223	0.38	0.97	Manual	1	10.00	2	10
Sample 2	Acetaldehyde	mg/m3	0.724	0.27	0.49	Manual	1	10.00	2	10
Sample 2	Formaldehyde	mg/m3	0.227	0.33	0.44	Manual	1	10.00	2	10
Sample 2	Propionaldehyde	mg/m3	1.289	0.25	0.59	Manual	1	10.00	2	10
Sample 3	Acetaldehyde	mg/m3	1.626	0.49	0.93	Manual	1	10.00	2	10
Sample 3	Butyraldehyde	mg/m3	0.181	0.17	0.70	Manual	1	10.00	2	10
Sample 3	Formaldehyde	mg/m3	0.266	0.79	0.57	Manual	1	10.00	2	10

Sample description	Measurand description	ISO 13528:2022 - test for adequate homogeneity
Sample 1	Acetaldehyde	Ok
Sample 1	Butyraldehyde	Ok
Sample 1	Formaldehyde	Ok
Sample 1	Propionaldehyde	Ok
Sample 2	Acetaldehyde	Ok
Sample 2	Formaldehyde	Ok
Sample 2	Propionaldehyde	Ok
Sample 3	Acetaldehyde	Ok
Sample 3	Butyraldehyde	Ok
Sample 3	Formaldehyde	Ok