Ohmics

AUTOMATED DISSOLVED GAS ANALYSIS

Transformer DGA Report

2 units · 16 samples · 2 laboratory reports · Evaluated under IEEE Std. C57.104-2019 (DGA status), with C57.104-2008 Table 1 conditions shown for comparison

Prepared for	Anonymized for public release
Job	SAMPLE-DGA-01
Generated	May 29, 2026
Units	Unit 1: TX-1 Unit 2: TX-2
Reports analyzed	lab-1-report.pdf (Laboratory 1, 14 samples) lab-2-retest.pdf (Laboratory 2, 2 samples)

No engineer reviewed this report. Software produced it from the uploaded lab reports and released it automatically. Check each conclusion before acting on it; none of them is an engineering determination.

This is an automated interpretation of laboratory data, not an engineering determination.

The conclusions apply published consensus methods (IEEE Std. C57.104, Rogers ratios, Key Gas, Duval triangles and energy indices) to the values transcribed from the uploaded laboratory reports. They depend on the accuracy of those reports and of the transcription. DGA shows that gas is being produced and suggests the type of fault; it cannot locate a fault or establish the condition of a transformer by itself. Decisions to remove a unit from service, to discount a sample, or to defer action should be made by a qualified engineer with the full history of the unit.

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CONCLUSIONS AND RECOMMENDATIONS

Findings and Recommendations

Summary

This report covers 2 transformers and 16 samples. Under IEEE Std. C57.104-2019, the latest samples (May 22, 2026) put TX-1 in DGA Status 3, with CH4 and C2H6 rising at or above the Table 4 rate, and TX-2 in DGA Status 1. Under IEEE Std. C57.104-2008, the latest samples (May 22, 2026) put TX-1 in Condition 3, set by ethane (C2H6), and TX-2 in Condition 1. Two units returned near-identical results on the same day, which rarely happens with real faults, so those samples are likely mixed up or contaminated. Duval Triangle 1 indicates a thermal fault below 300 °C for each affected unit.

Recommendations

1. For TX-1, IEEE Std. C57.104-2019 DGA Status 3 suggests more surveillance, fault identification and further testing, and suggests consulting the manufacturer or a transformer expert.
2. Locate the source with the follow-up tests listed under each unit. DGA can indicate a fault but cannot locate it.
3. Have a licensed Professional Engineer review any sample marked as likely contaminated before it is discounted.
4. Review sampling practice (ASTM D923). At least one sample shows air contamination.

Findings

Suspect samples come first. The "questionable samples removed" graphs leave them out, and the tables keep every sample.

CRITICAL · X-01

1. TX-1 and TX-2 gave near-identical results on May 5, 2026

All 9 gases within 12 % (H2 54 vs 53, CH4 273 vs 284, C2H6 91 vs 92, C2H4 607 vs 618 ppm). Two transformers with different histories rarely produce the same gases, so this is likely a sample mix-up or contamination.

Recommendation: Urgently have a different testing agency or technician take the next samples from both units. If you need a licensed Professional Engineer, contact info@pefgconsulting.com.

SIGNIFICANT · Unit1-01

2. TX-1: May 5, 2026 sample looks contaminated

Fault gases jumped on May 5, 2026 (Laboratory 1), then the May 22, 2026 retest (Laboratory 2) came back at the earlier level. A real fault rarely clears on its own without oil processing. The sample is left off the "questionable samples removed" graphs and out of every rate.

Recommendation: Treat it as likely contaminated, but have a licensed Professional Engineer review it before you discount it. If you need a licensed Professional Engineer, contact info@pefgconsulting.com.

SIGNIFICANT · Unit1-02

3. TX-1: DGA Status 3 (IEEE Std. C57.104-2019)

At or above the Table 1 norm: C2H6 101 ppm (norm 90). Change at or above Table 3 since February 3, 2026: C2H6 +25 ppm (norm 25). Rate at or above Table 4, over 6 samples and 556 days: CH4 +10 ppm/year (norm 10), C2H6 +26.3 ppm/year (norm 9). The lab changed between these samples, which can account for part of the change. O2/N2 is 0.08, so the 0.2-or-below section; age is 23 years, so the 10-30 column. The status classifies this DGA result, not the condition of the transformer.

Recommendation: Increase surveillance, identify the fault type, and consider further testing and a call to the manufacturer or a transformer expert. Consider continuous monitoring, such as an online gas monitor, once all the information has been reviewed; the guide does not make this automatic (§5.3.4). If you need a licensed Professional Engineer, contact info@pefgconsulting.com.

SIGNIFICANT · Unit1-03

4. TX-1: Condition 3 (IEEE Std. C57.104-2008 Table 1)

Set by C2H6 101 ppm on May 22, 2026 (Condition 1 limit C2H6 65 ppm). The lab changed since the February 3, 2026 sample, which was Condition 2; confirm the step with the next sample.

Recommendation: Use the fault-type results and trend graphs below to find the source.

SIGNIFICANT · Unit2-01

5. TX-2: May 5, 2026 sample looks contaminated

Fault gases jumped on May 5, 2026 (Laboratory 1), then the May 22, 2026 retest (Laboratory 2) came back at the earlier level. A real fault rarely clears on its own without oil processing. The sample is left off the "questionable samples removed" graphs and out of every rate.

Recommendation: Treat it as likely contaminated, but have a licensed Professional Engineer review it before you discount it. If you need a licensed Professional Engineer, contact info@pefgconsulting.com.

OBSERVATION · Unit1-05

6. TX-1: most likely thermal fault below 300 °C (Duval Triangle 1)

Rogers no case; IEC code 020 (Thermal fault, 150 to 300 °C); Key Gas: overheated oil; Duval Triangle 1 T1, Triangle 4 O; Pentagons T1 and O. O2/N2 has fallen from 0.14 on May 14, 2025 to 0.08, which supports a thermal fault (Annex D.9.1).

Recommendation: Start with the fault type the methods agree on.

OBSERVATION · Unit1-06

7. TX-1: tests to locate the source

DGA can indicate that a fault is generating gas, but it cannot locate the fault.

Recommendation: Consider DGA at 0, 24 and 48 h with the unit idle, winding resistance on each tap, core-to-ground megger, excitation current, IR scan of bushing and lead connections, furan analysis, and a check of the Buchholz relay, pressure relief and gauges.

OBSERVATION · Unit1-08

8. TX-1: paper gases rising since February 3, 2026

NEI-CO up 0.67 kJ/kL. CO/CO2 -23.5 %. CO2 rose faster than CO, which commonly indicates general overheating of the paper.

Recommendation: Shorten the sampling interval until it levels off.

OBSERVATION · Unit1-09

9. TX-1: air in 1 sample (October 29, 2025)

O2 and N2 are far above the neighboring samples. Its O2/N2 values are left off the "removed" graphs, and H2 and CO may read low.

Recommendation: Review sampling practice (ASTM D923).

OBSERVATION · Unit2-06

10. TX-2: high oxygen for a nitrogen-blanketed unit

O2/N2 is 0.33 (above 0.2). Air may be getting into the oil or into the samples, though C57.104-2019 notes the ratio alone cannot show whether a unit is sealed.

Recommendation: Check the nitrogen supply, bladder, gaskets and pressure relief, and how samples are drawn.

OBSERVATION · Unit2-07

11. TX-2: paper gases rising since October 29, 2025

NEI-CO up 1.93 kJ/kL. CO/CO2 +26.8 %. The change is too small to indicate where paper is being heated.

Recommendation: Shorten the sampling interval until it levels off.

INFORMATION · Unit1-04

12. TX-1: C57.104-2008 Table 3 would suggest monthly sampling

TDCG changed +0.3 ppm/day since the last trusted sample.

Recommendation: Shown for comparison. The C57.104-2019 status sets the recommendations in this report.

INFORMATION · Unit1-07

13. TX-1: sample more often until the trend is clear

More samples make the trend clearer, because normal scatter between DGA results averages out over several points.

Recommendation: Take 3 samples in week 1 and 2 or 3 in week 2, then weekly through week 4, twice a month in months 2 and 3, and monthly through month 6. After that, set the interval by DGA status.

INFORMATION · Unit1-10

14. TX-1: 2 labs in the history

Laboratory 1 and Laboratory 2. Results differ between labs (IEEE Std. C57.104-2008 Table 1 Note 2).

Recommendation: Trend with one lab where possible; confirm any step at a lab change.

INFORMATION · Unit2-02

15. TX-2: DGA Status 1 (IEEE Std. C57.104-2019)

On May 22, 2026, all gases are below the Table 1 norms, and no change or rate has reached Table 3 or Table 4. O2/N2 is 0.33, so the above-0.2 section; age is 23 years, so the 10-30 column. The status classifies this DGA result, not the condition of the transformer.

Recommendation: Keep routine sampling under your company policy or the manufacturer’s recommendations.

INFORMATION · Unit2-03

16. TX-2: Condition 1 (IEEE Std. C57.104-2008 Table 1)

All gases and TDCG (250 ppm) are within Condition 1 on May 22, 2026.

Recommendation: Keep routine sampling.

INFORMATION · Unit2-04

17. TX-2: C57.104-2008 Table 3 would suggest annual sampling

TDCG changed +0.3 ppm/day since the last trusted sample.

Recommendation: Shown for comparison. The C57.104-2019 status sets the recommendations in this report.

INFORMATION · Unit2-05

18. TX-2: no fault type indicated

Rogers no case; IEC code 002 (Code not in the diagnosis table); Key Gas: no pattern; Duval Triangle 1 T3, Triangle 5 T3; Pentagons T3 and T3-H. Every gas is below its C57.104-2019 Table 1 norm. The guide advises against fault typing at these levels (§5.2.1), so these are for reference only.

INFORMATION · Unit2-08

19. TX-2: 2 labs in the history

Laboratory 1 and Laboratory 2. Results differ between labs (IEEE Std. C57.104-2008 Table 1 Note 2).

Recommendation: Trend with one lab where possible; confirm any step at a lab change.

These results come from published methods applied to lab data. Have a licensed Professional Engineer review any decision to take a unit out of service or discount a sample. If you need a licensed Professional Engineer, contact info@pefgconsulting.com.

UNIT 1

TX-1

Nameplate (as printed by the laboratory)	
Designation	TX-1
Serial number	—
Manufacturer	—
Equipment	Generator step-up transformer
Rating	118,000 kVA
Voltage	345.0 / 18.0 kV
Oil volume	14,900 gal
Preservation	conservator sealed
Manufactured	2003
Samples	8 (2024-08-07 to 2026-05-22)

Gas-in-oil results (ppm)

All samples from all reports. # matches the graphs. Not detected = 0.

#	Date	Lab	H2	CH4	C2H6	C2H4	C2H2	CO	CO2	O2	N2	TDCG	Cond	Status	Flags
1	2024-08-07	Laboratory 1	5	27	49	1	0	59	1,141	347	8,652	141	1	1	
2	2024-11-12	Laboratory 1	3	30	54	1	0	74	1,093	1,012	9,874	162	1	1	
3	2025-05-14	Laboratory 1	39	34	67	2	0	81	1,056	2,281	16,124	223	**2**	**3**	
4	2025-07-07	Laboratory 1	2	33	68	2	0	70	1,039	1,157	10,863	175	**2**	**3**	
5	2025-10-29	Laboratory 1	3	**35**	**71**	1	0	86	1,082	3,098	20,210	196	**2**	**3**	Air in sample
6	2026-02-03	Laboratory 1	5	39	76	2	0	87	1,196	297	10,187	209	**2**	**3**	
7	2026-05-05	Laboratory 1	54	273	91	607	7	561	2,208	6,044	67,812	1,593	**4**	—	Questionable: retest did not repeat it; Matches another unit
8	2026-05-22	Laboratory 2	3	47	**101**	2	0	93	1,671	1,028	13,310	246	**3**	**3**	Lab change

Amber: above the C57.104-2019 Table 1 norm. Red: questionable sample. Cond: IEEE Std. C57.104-2008 condition. Status: IEEE Std. C57.104-2019 DGA status.

Sample quality screening

#	Date	Finding	Evidence
7	2026-05-05	**Questionable: retest did not repeat it**	February 3, 2026 → May 5, 2026 → May 22, 2026: CH4 39 → 273 → 47, C2H4 2 → 607 → 2, C2H2 0 → 7 → 0, CO 87 → 561 → 93 ppm.
5	2025-10-29	**Air in sample**	O2 3,098 / N2 20,210 ppm vs. typical 1,028 / 10,863 ppm.
7	2026-05-05	Matches another unit	All 9 gases within 12 % (H2 54 vs 53, CH4 273 vs 284, C2H6 91 vs 92, C2H4 607 vs 618 ppm).

UNIT 1 · IEEE STD. C57.104-2019

DGA Status 3

Sample 8, 2026-05-22. O2/N2 0.08: 0.2 or below section. Age 23 years: 10-30 yr column. Rate from 6 samples over 556 days.

Gas	ppm	Table 1 norm	Table 2 norm	Change since 2026-02-03	Table 3 norm	Rate (ppm/yr)	Table 4 norm	Result
Hydrogen (H2)	3	75	200	-2	40	-6.8	20	Below
Methane (CH4)	47	90	150	+8	30	**+10.0**	10	Table 4
Ethane (C2H6)	**101**	90	175	**+25**	25	**+26.3**	9	Table 1, Table 3, Table 4
Ethylene (C2H4)	2	50	95	0	20	+0.4	7	Below
Acetylene (C2H2)	0	1	2	0	any increase	0.0	any rise	Below
Carbon monoxide (CO)	93	900	1,100	+6	250	+13.0	100	Below
Carbon dioxide (CO2)	1,671	10,000	14,000	+475	2,500	+319.2	1,000	Below

Result: the tables this gas reached. Below: below every norm that applies. Status 3 needs a gas above Table 2 or a rate above Table 4. Status 1 needs every gas, change and rate below its norm. Anything else is Status 2.

Status of each sample

#	Date	O2/N2	Section	Age column	Rate basis	Status	Confirmation	What took it out of Status 1
1	2024-08-07	0.04	0.2 or below	10-30 yr	—	1		
2	2024-11-12	0.10	0.2 or below	10-30 yr	—	1		
3	2025-05-14	0.14	0.2 or below	10-30 yr	3 over 280 d	3	Confirmation sample suggested	H2, C2H6 rate at Table 4
4	2025-07-07	0.11	0.2 or below	10-30 yr	4 over 334 d	3		C2H6 rate at Table 4
5	2025-10-29	—	above 0.2	10-30 yr	5 over 448 d	3		C2H6 above Table 2; CH4, C2H6 rate at Table 4; CH4 at Table 1
6	2026-02-03	0.03	0.2 or below	10-30 yr	6 over 545 d	3		C2H6 rate at Table 4
8	2026-05-22	0.08	0.2 or below	10-30 yr	6 over 556 d	3		CH4, C2H6 rate at Table 4; C2H6 at Table 1; C2H6 change at Table 3

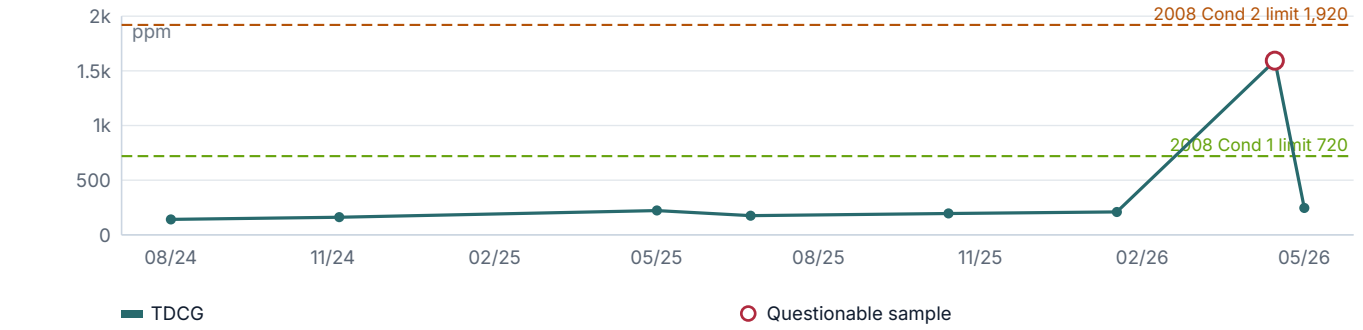
Samples marked questionable in the screening are left out. A status classifies the DGA result, not the condition of the transformer (§6.1). C57.104 is a guide and its norms are statistical (§5.4), so a result below them does not show a unit is free of faults. Owners may set their own norms, and an expert may consider a lower status when samples over a year or more show no active gassing (§6.1.2).

UNIT 1 · TRENDS

Dashed lines: IEEE C57.104-2008 Table 1 condition limits, for comparison with earlier reports. The 2019 edition keeps the 2008 method only as historical material in its Annex G. Dotted lines: IEEE C57.104-2019 Table 1 and Table 2 norms for the O2/N2 section and age of the latest trusted sample. TDCG has only the 2008 lines, because the 2019 edition does not use TDCG. "//" on the date axis marks a long gap between samples.

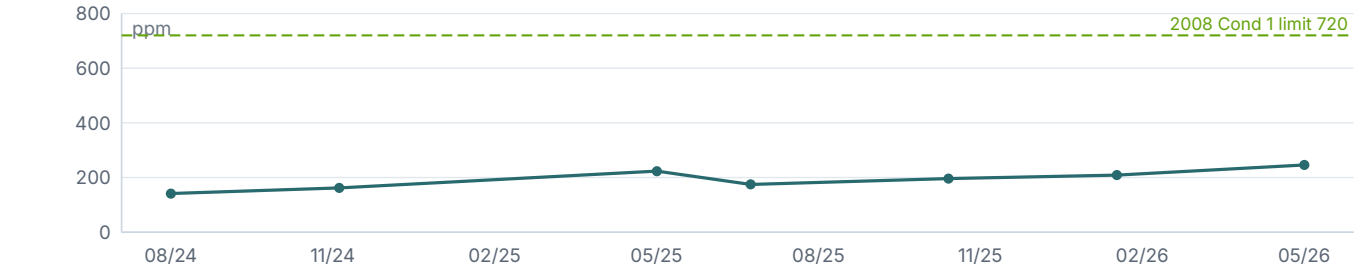
TDCG

All samples



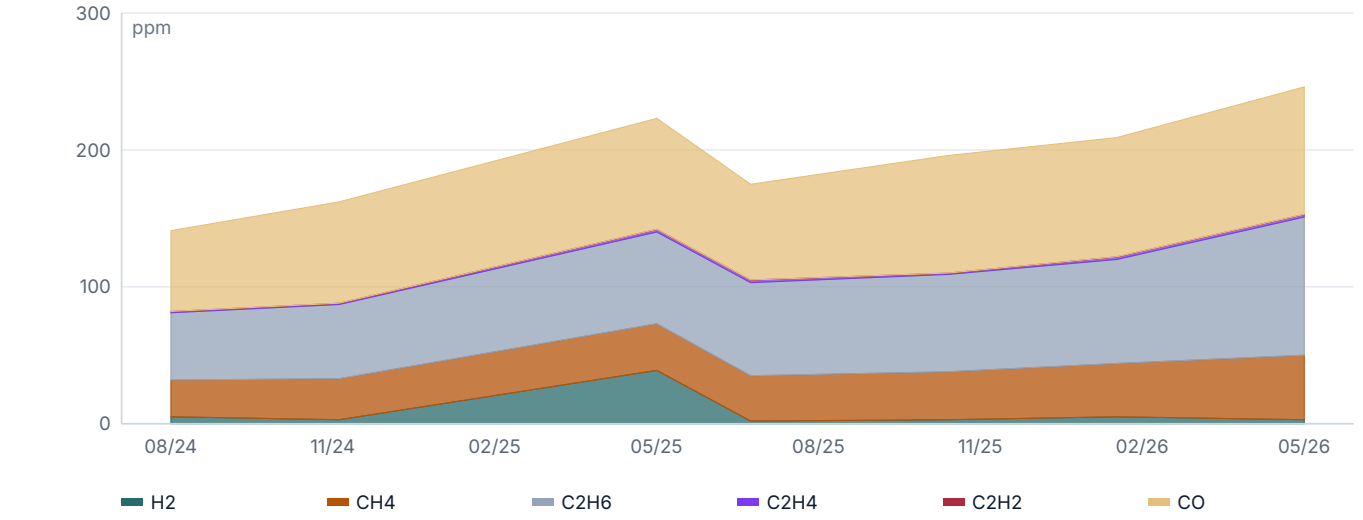
TDCG

Questionable samples removed



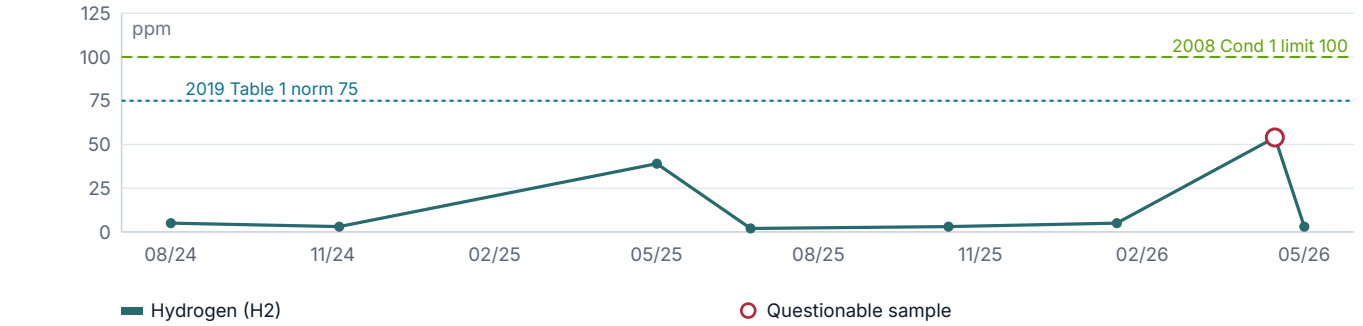
Combustible gases, stacked

One band per gas; the top edge is TDCG · questionable samples removed · IEEE C57.104-2019 §5.3.3



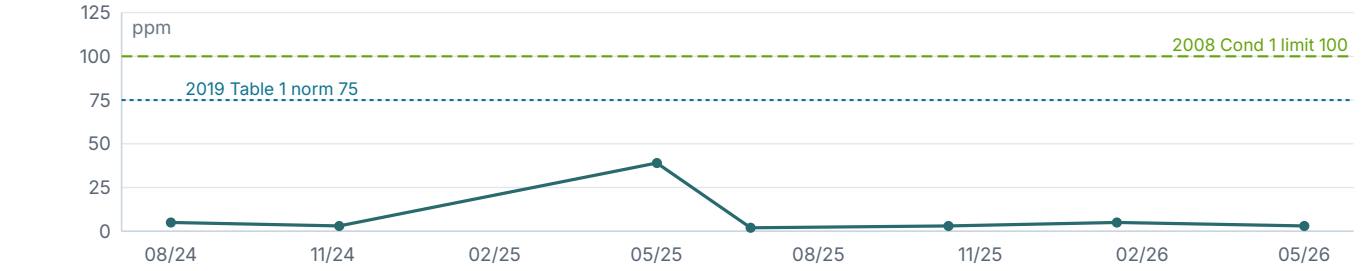
Hydrogen (H2)

All samples



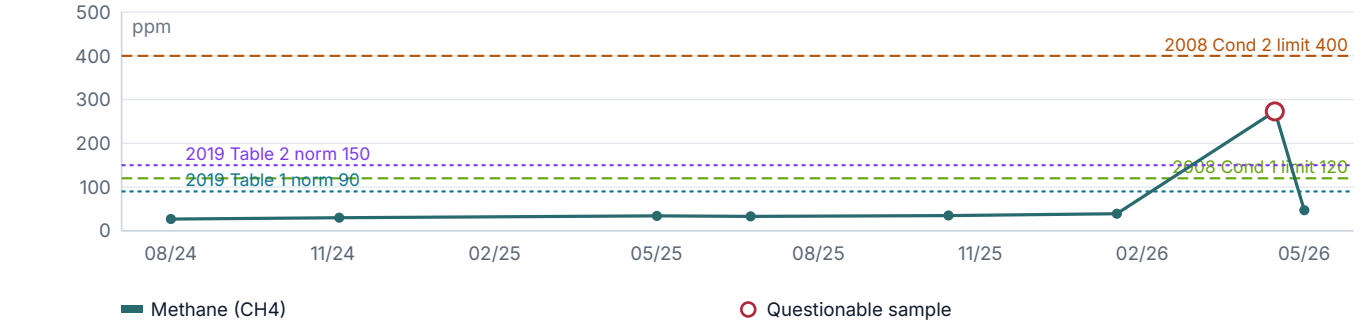
Hydrogen (H2)

Questionable samples removed



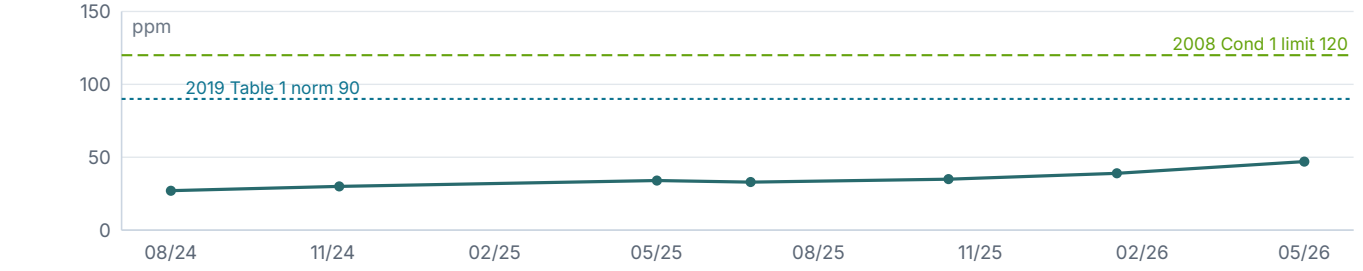
Methane (CH4)

All samples



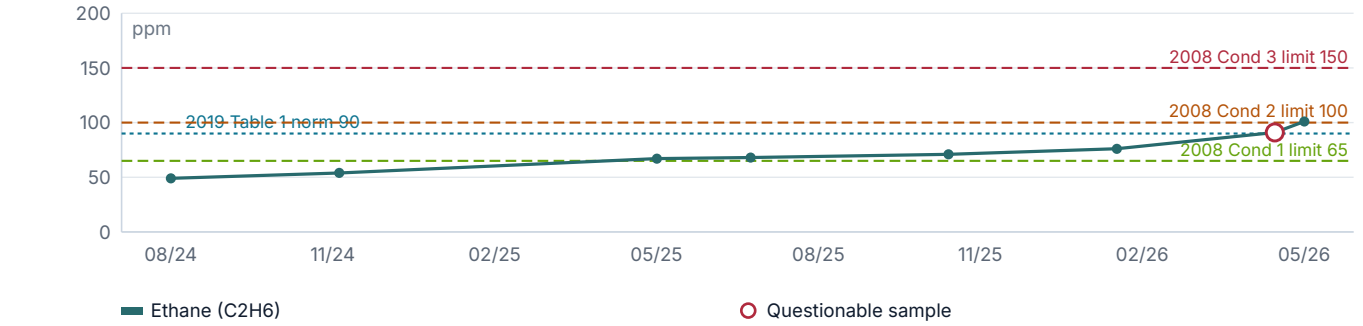
Methane (CH4)

Questionable samples removed



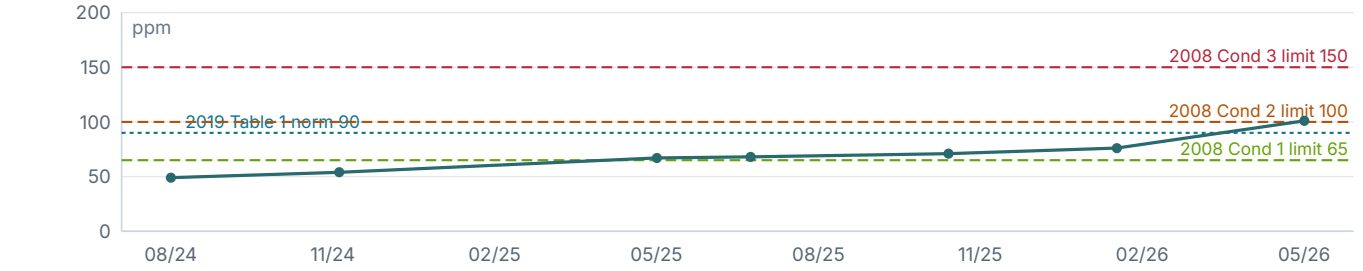
Ethane (C2H6)

All samples



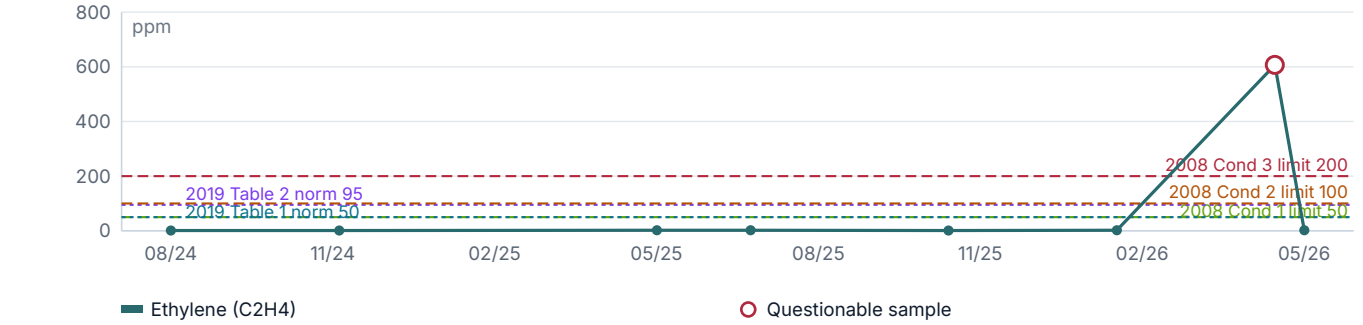
Ethane (C2H6)

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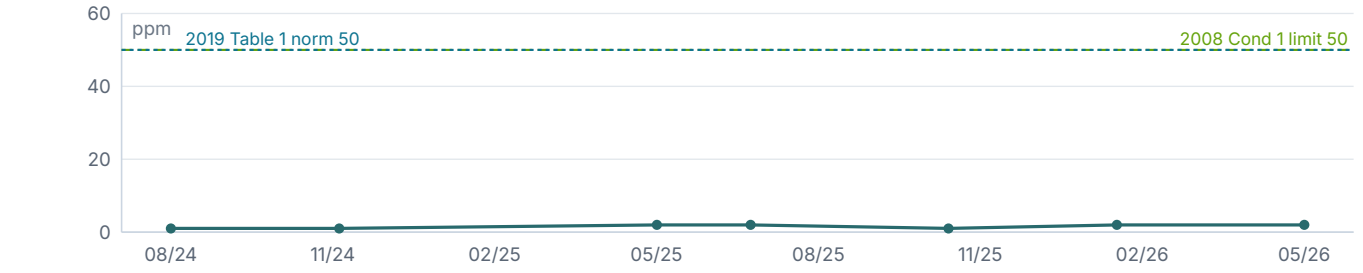
Ethylene (C2H4)

All samples



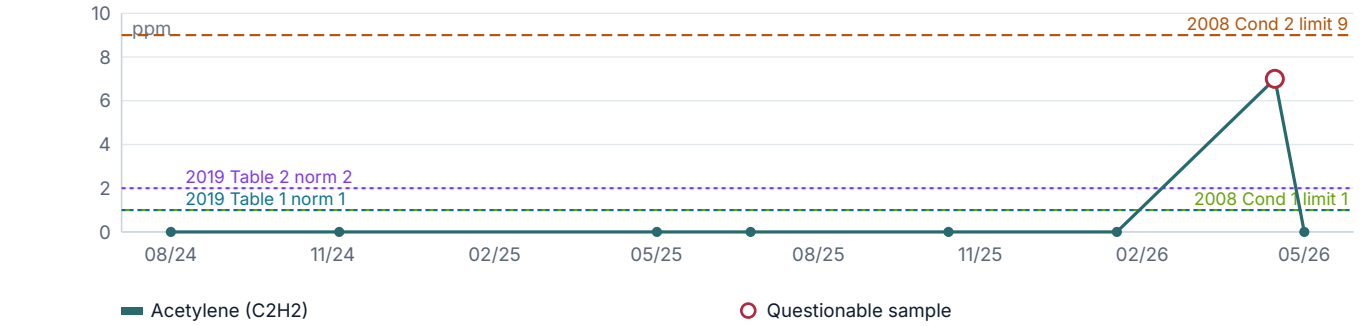
Ethylene (C2H4)

Questionable samples removed



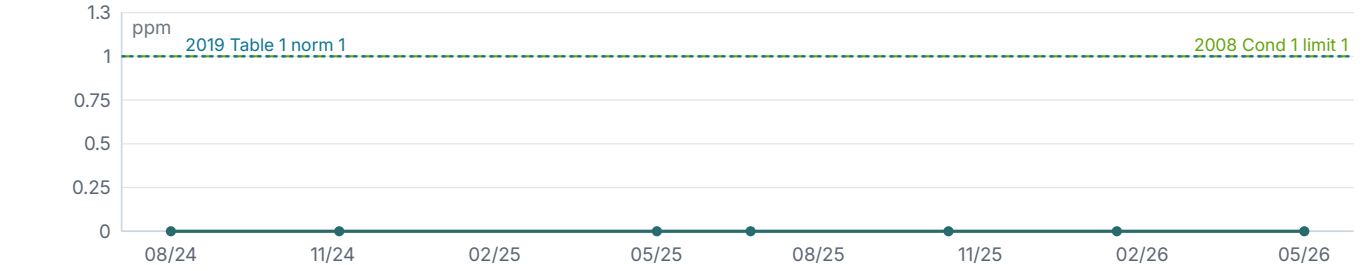
Acetylene (C2H2)

All samples



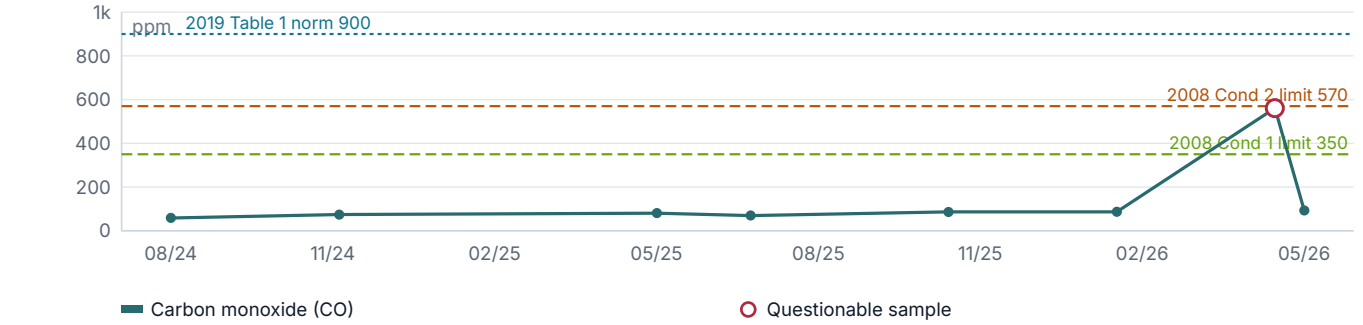
Acetylene (C2H2)

Questionable samples removed



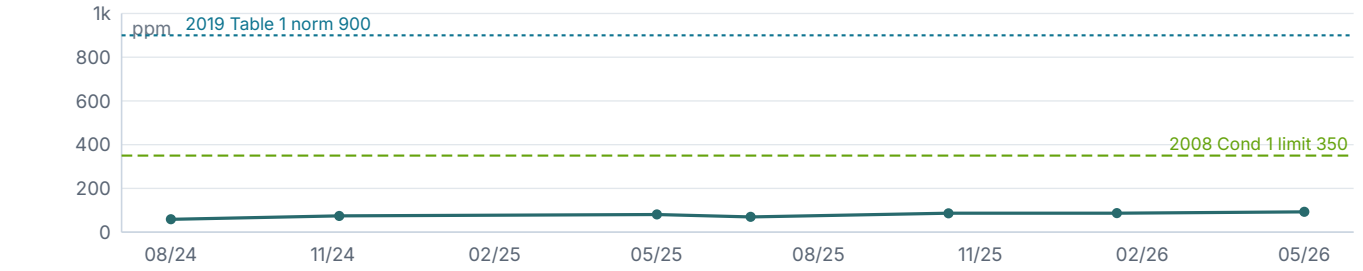
Carbon monoxide (CO)

All samples



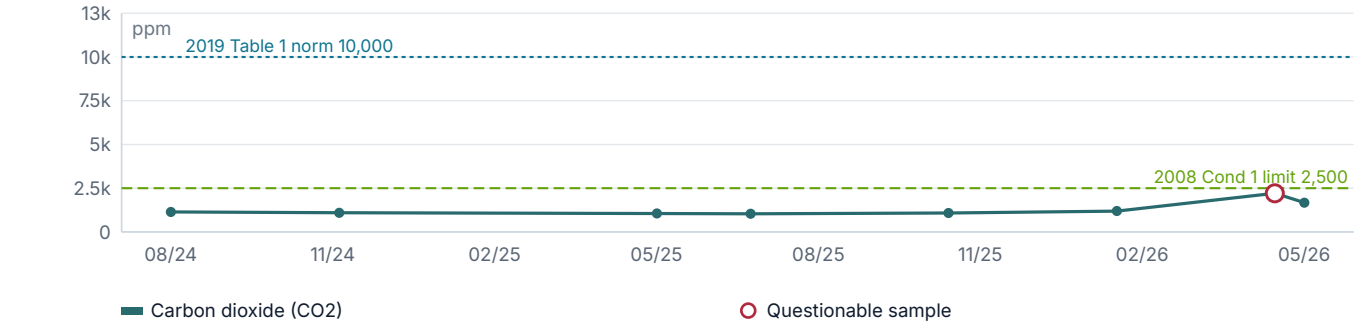
Carbon monoxide (CO)

Questionable samples removed



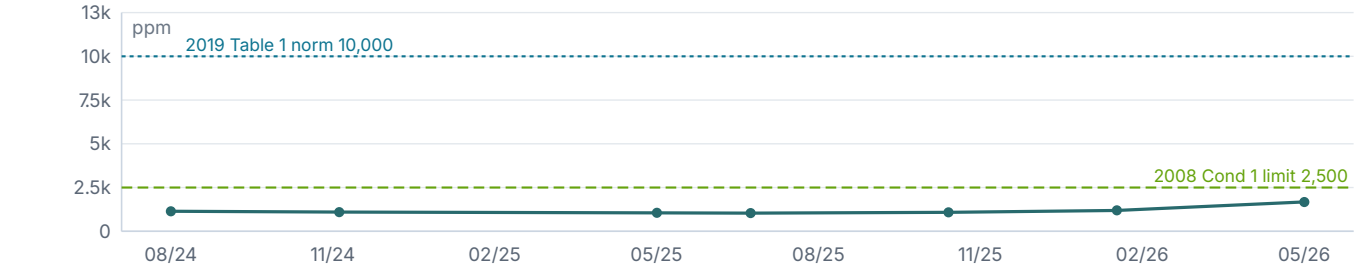
Carbon dioxide (CO2)

All samples



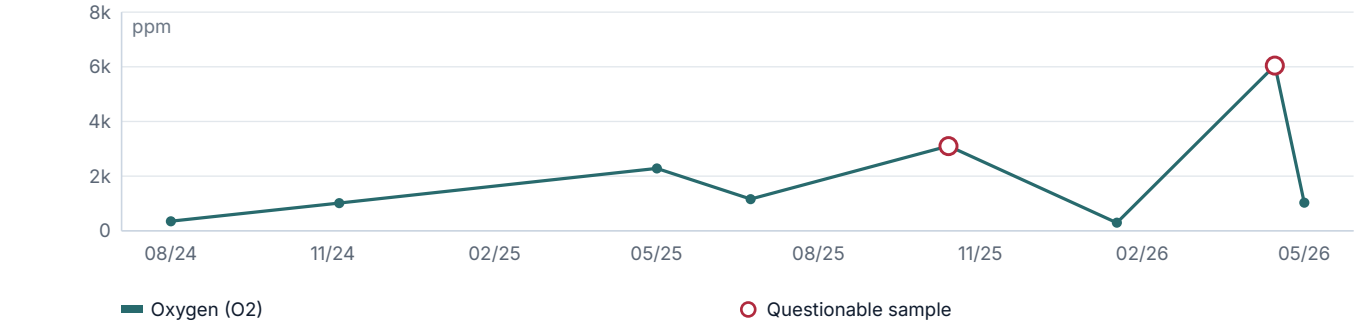
Carbon dioxide (CO2)

Questionable samples removed



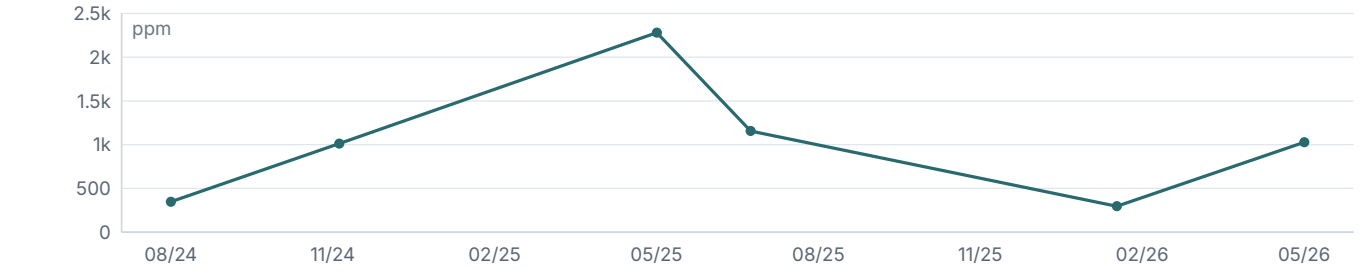
Oxygen (O2)

All samples



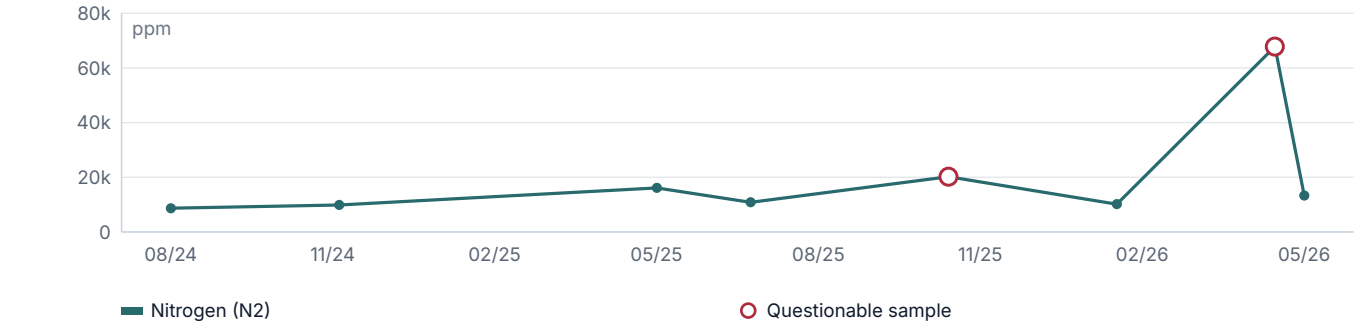
Oxygen (O2)

Questionable samples removed



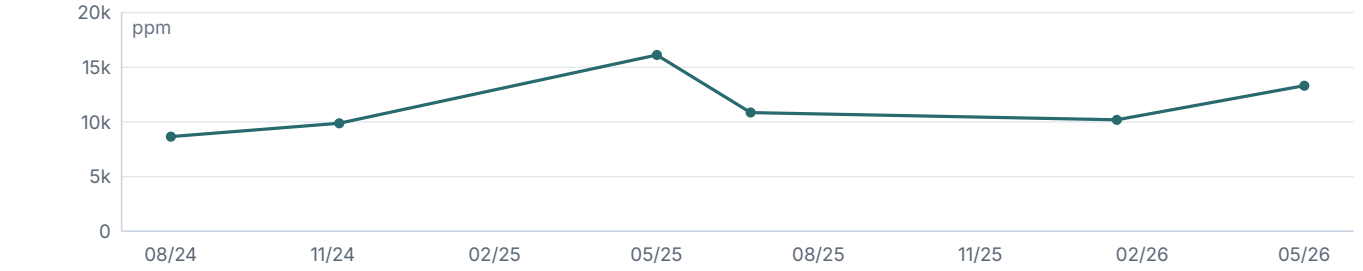
Nitrogen (N2)

All samples



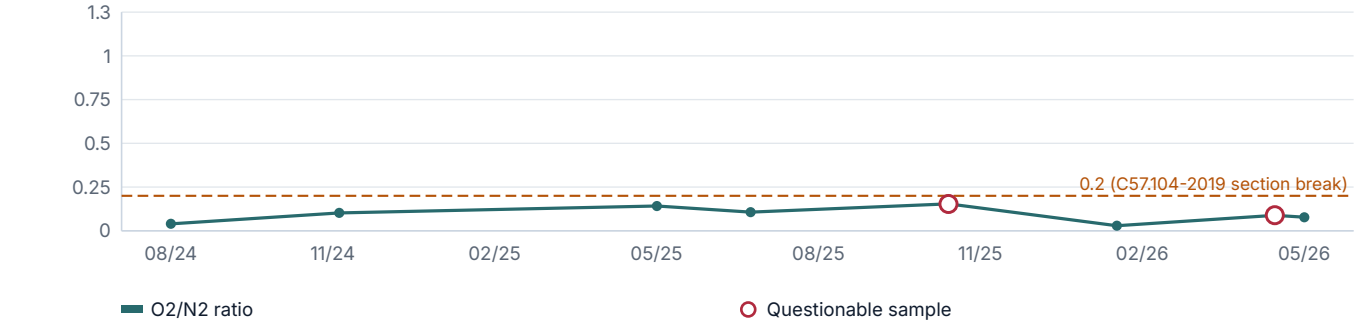
Nitrogen (N2)

Questionable samples removed



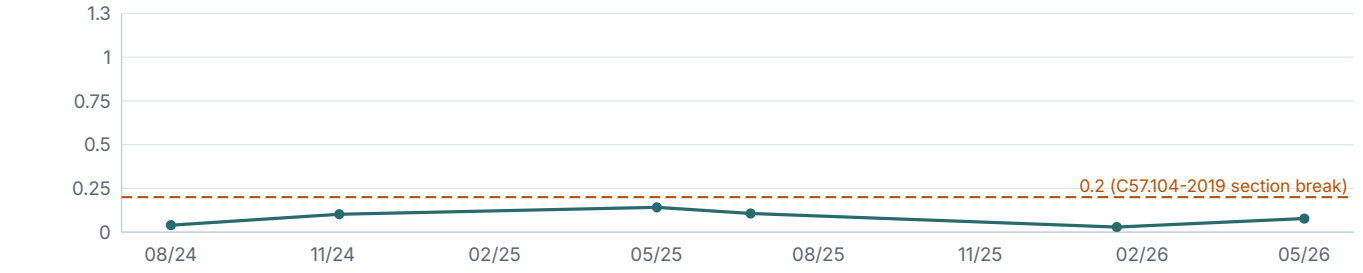
O2/N2 ratio

All samples



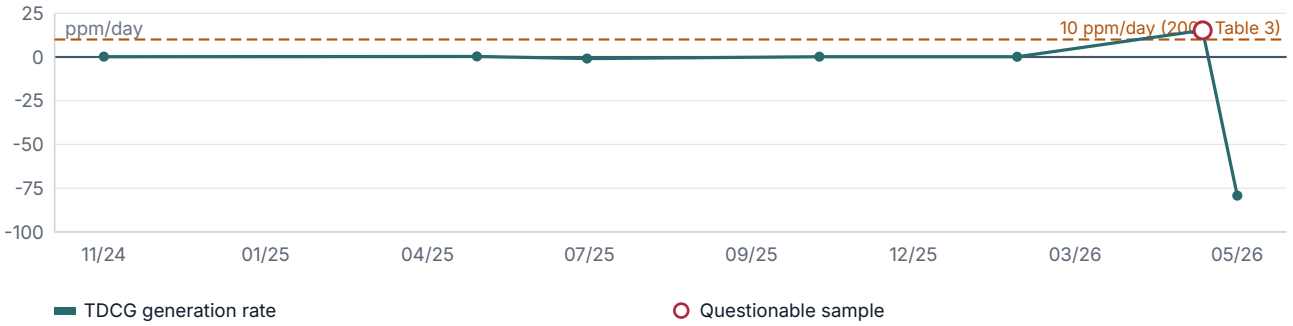
O2/N2 ratio

Questionable samples removed



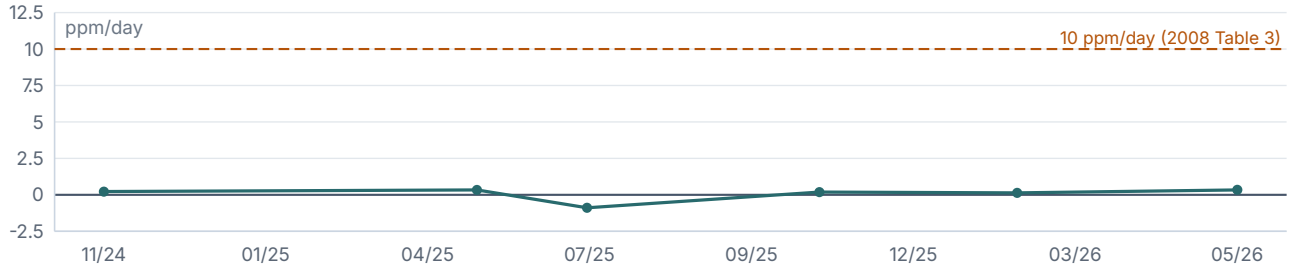
TDCG generation rate

All samples



TDCG generation rate

Questionable samples removed



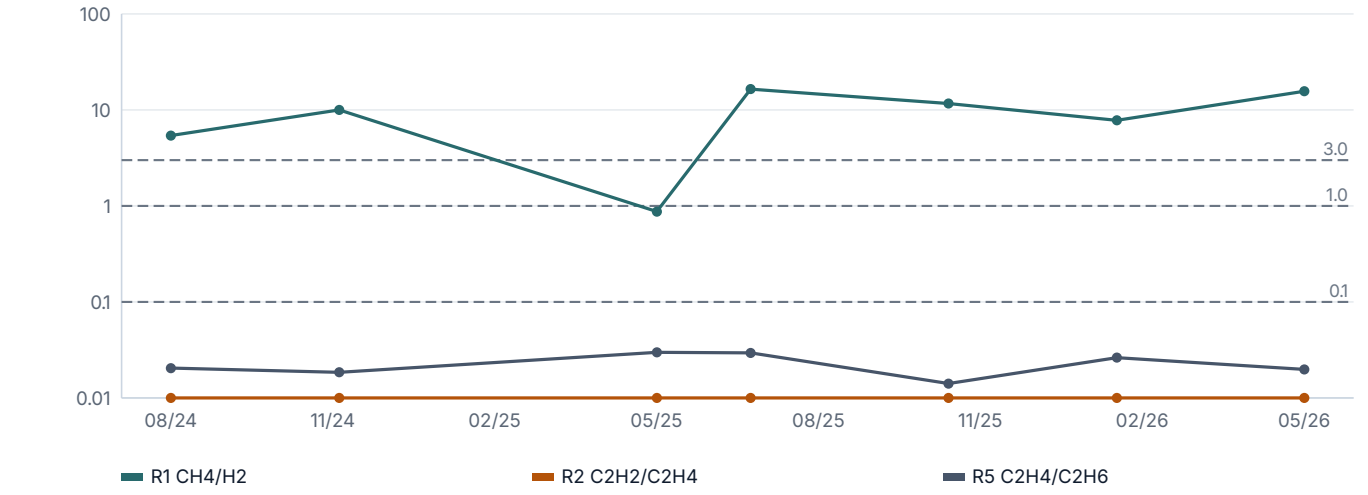
UNIT 1 · RATIO METHODS

R1 = CH4/H2, R2 = C2H2/C2H4, R5 = C2H4/C2H6. Gray rows are within Condition 1 and DGA Status 1, where the ratios are not diagnostic.

#	Date	R1	R2	R5	Rogers case	IEC code	Key Gas	CO2/CO	NEI-HC	NEI-CO	Cond	
1	2024-08-07	5.40	0.00	0.02	No case	020 Thermal fault, 150 to 300 °C	—	19.3	0.30	1.81	1	
2	2024-11-12	10.0	0.00	0.02	No case	020 Thermal fault, 150 to 300 °C	—	14.8	0.33	1.81	1	
3	2025-05-14	0.87	0.00	0.03	0: Unit normal	000 No fault	overheated oil	13.0	0.41	1.79	2	
4	2025-07-07	16.5	0.00	0.03	No case	020 Thermal fault, 150 to 300 °C	overheated oil	14.8	0.41	1.72	2	
5	2025-10-29	11.7	0.00	0.01	No case	020 Thermal fault, 150 to 300 °C	overheated oil	12.6	0.42	1.85	2	
6	2026-02-03	7.80	0.00	0.03	No case	020 Thermal fault, 150 to 300 °C	overheated oil	13.7	0.46	2.01	2	
7	2026-05-05	5.06	0.01	6.67	5: Thermal fault above 700 °C	022 Thermal fault above 700 °C	overheated oil	3.94	4.23	5.52	4	questionable
8	2026-05-22	15.7	0.00	0.02	No case	020 Thermal fault, 150 to 300 °C	overheated oil	18.0	0.59	2.67	3	latest trusted

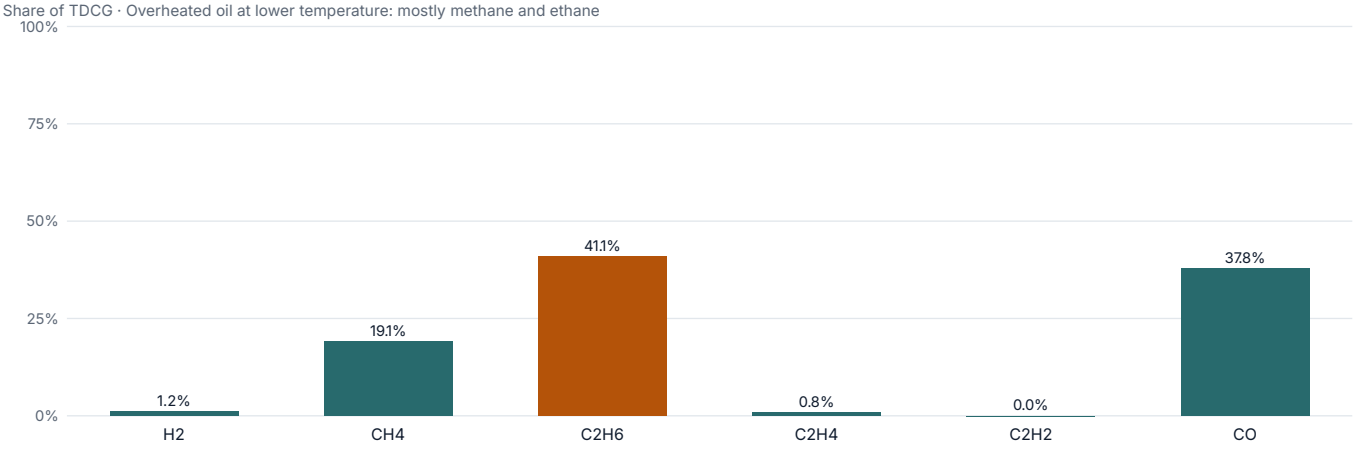
Rogers ratios R1, R2, R5

Questionable samples removed · log scale



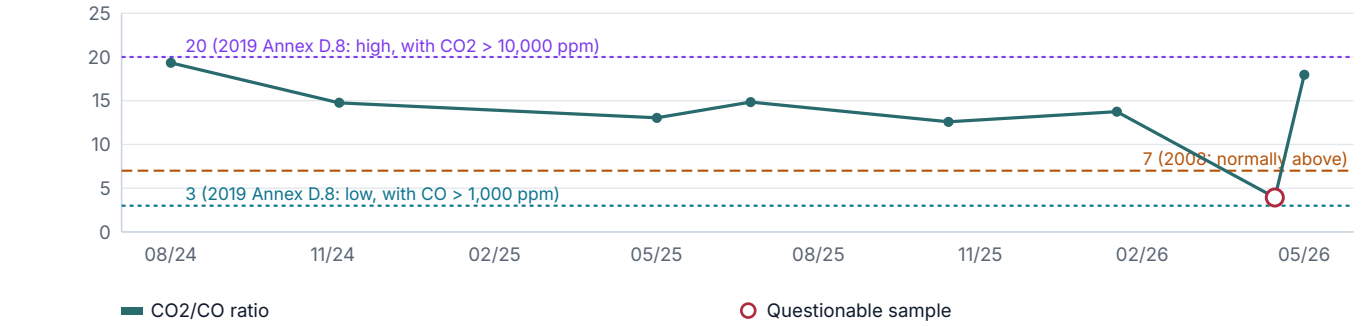
Key Gas, sample 8 (2026-05-22)

Share of TDCG · Overheated oil at lower temperature: mostly methane and ethane



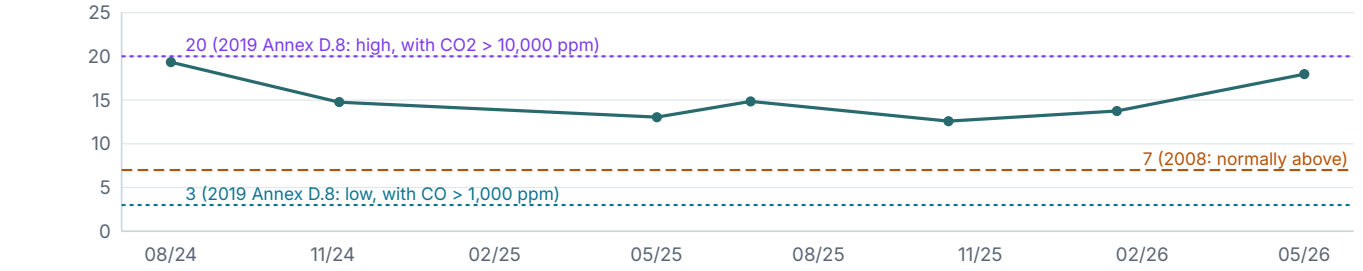
CO2/CO ratio

All samples



CO2/CO ratio

Questionable samples removed

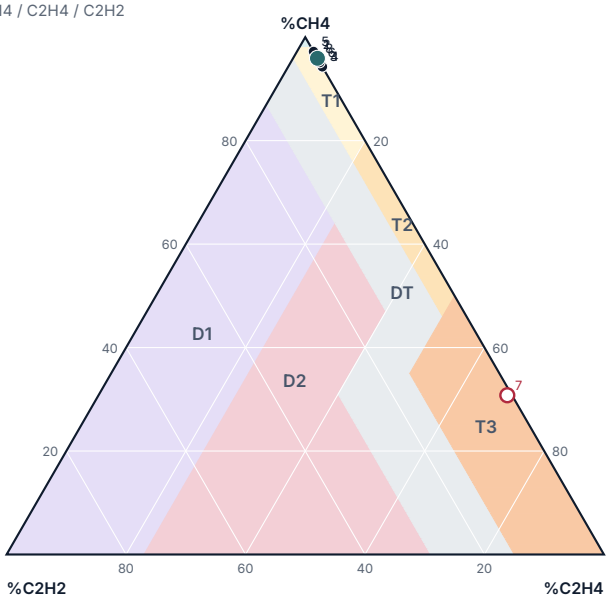


UNIT 1 · DUVAL TRIANGLES AND PENTAGONS

Numbers match the results table. Teal: latest trusted sample. Hollow red: questionable. Triangle 4 applies to T1 results and Triangle 5 to T2/T3, but all samples are plotted.

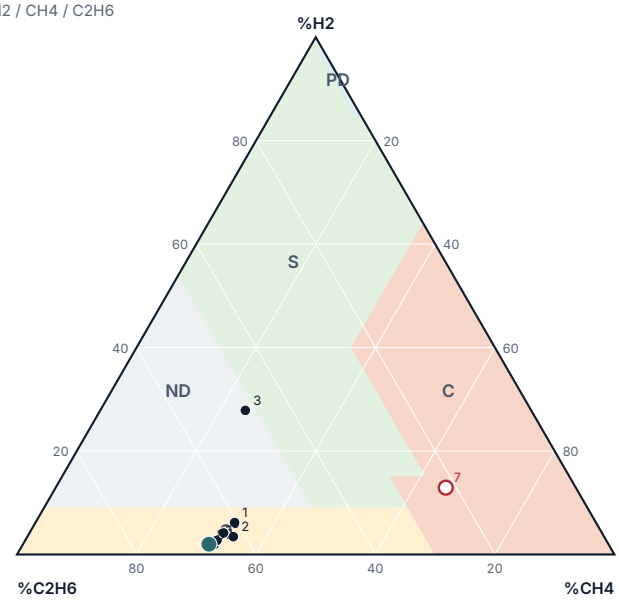
Duval Triangle 1

CH4 / C2H4 / C2H2



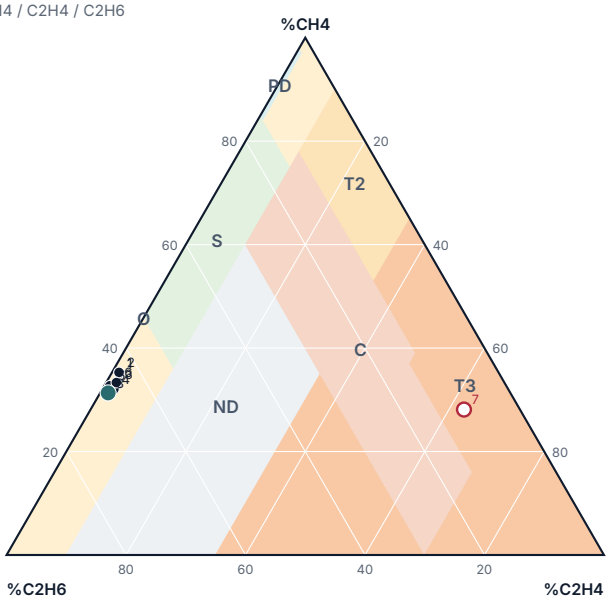
Duval Triangle 4 (low-temperature faults)

H2 / CH4 / C2H6



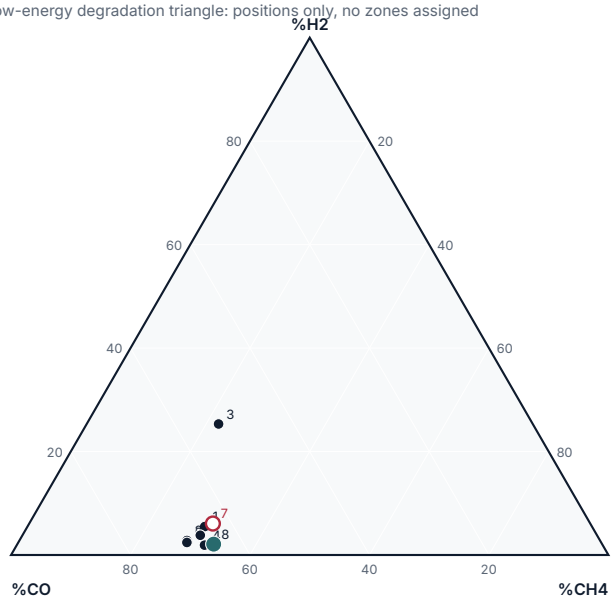
Duval Triangle 5 (high-temperature faults)

CH4 / C2H4 / C2H6



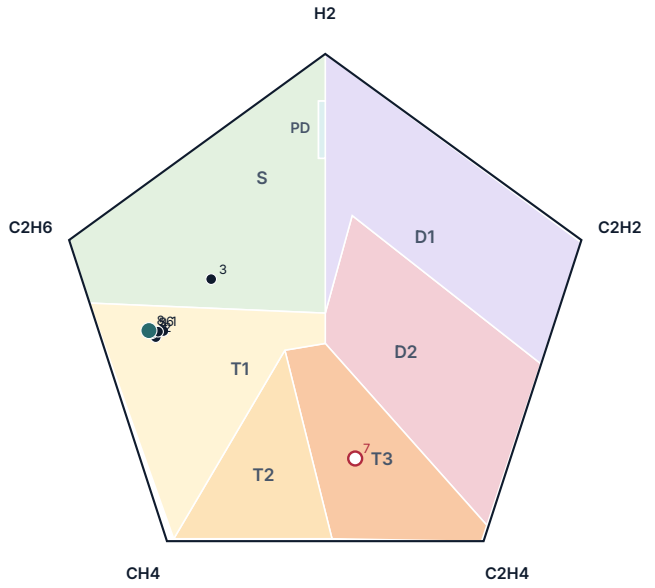
LEDT (H2 / CO / CH4)

Low-energy degradation triangle: positions only, no zones assigned



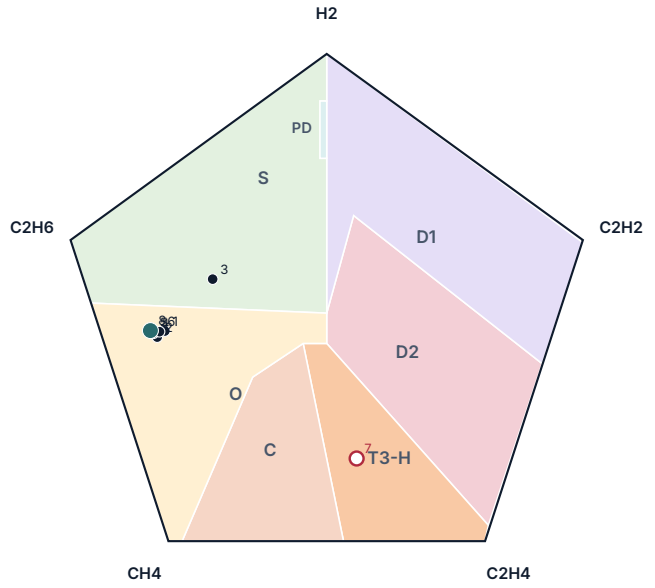
Duval Pentagon 1

Centroid of the H2, CH4, C2H2, C2H4 and C2H6 pentagon



Duval Pentagon 2

Same point; zones separate oil-only T3 from paper carbonization



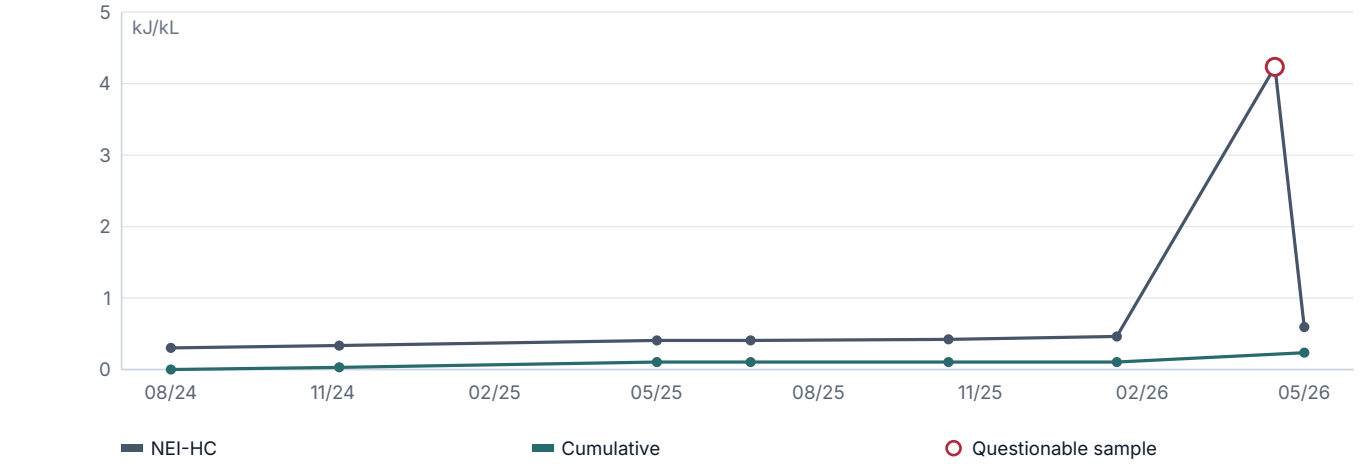
#	Date	Triangle 1	Triangle 4	Triangle 5	Pentagon 1	Pentagon 2
1	2024-08-07	T1: thermal fault below 300 °C	O	O	T1	O
2	2024-11-12	T1: thermal fault below 300 °C	O	O	T1	O
3	2025-05-14	T1: thermal fault below 300 °C	ND	O	S	S
4	2025-07-07	T1: thermal fault below 300 °C	O	O	T1	O
5	2025-10-29	T1: thermal fault below 300 °C	O	O	T1	O
6	2026-02-03	T1: thermal fault below 300 °C	O	O	T1	O
7	2026-05-05	T3: thermal fault above 700 °C	C	T3	T3	T3-H
8	2026-05-22	T1: thermal fault below 300 °C	O	O	T1	O

UNIT 1 · RELIABILITY-BASED INDICATORS

NEI weights each gas by the energy it takes to form (Jakob and Dukarm, 2015; IEEE C57.104-2019 Annex F): one number for oil gases, one for paper gases. The cumulative line only counts increases, so gas lost to leaks or degassing does not hide earlier gassing. Annex F reports that one utility treats an NEI-HC increase of 0.5 kJ/kL over any interval as cause for concern.

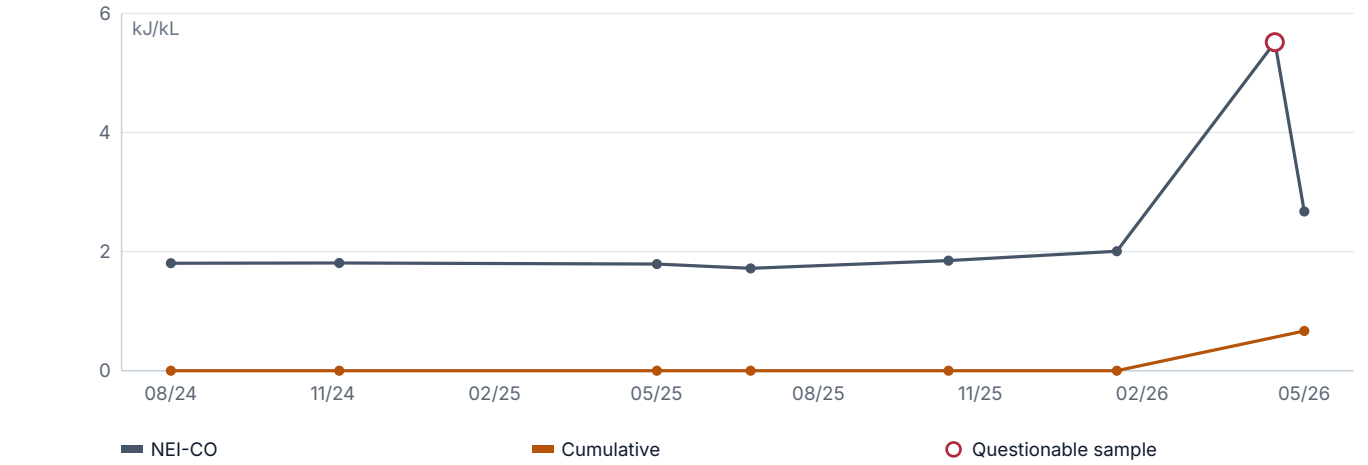
NEI-HC (oil)

Per sample and cumulative



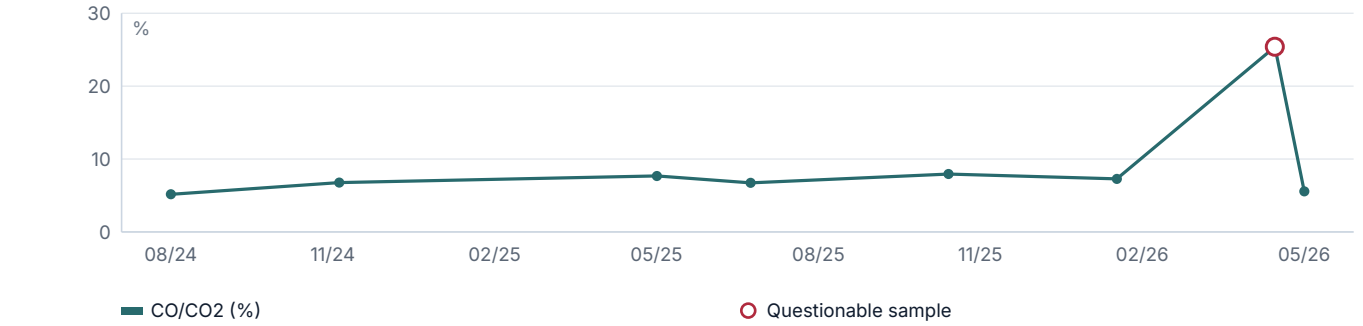
NEI-CO (paper)

Per sample and cumulative



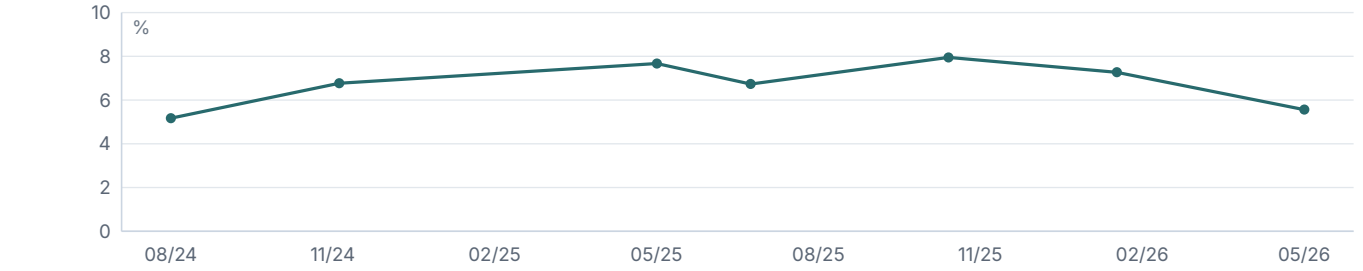
CO/CO2 (%)

All samples



CO/CO2 (%)

Questionable samples removed



Gassing events

Index	From	To	Increase (kJ/kL)	Interpretation
NEI-CO	2026-02-03	2026-05-22	0.67	CO/CO2 -23 %. CO2 rose faster than CO, which commonly indicates general overheating of the paper.

UNIT 2

TX-2

Nameplate (as printed by the laboratory)	
Designation	TX-2
Serial number	—
Manufacturer	—
Equipment	Drive isolation transformer
Rating	5,250 kVA
Voltage	4.2 / 2.1 kV
Oil volume	1,380 gal
Preservation	nitrogen blanket
Manufactured	2003
Samples	8 (2024-08-07 to 2026-05-22)

Gas-in-oil results (ppm)

All samples from all reports. # matches the graphs. Not detected = 0.

#	Date	Lab	H2	CH4	C2H6	C2H4	C2H2	CO	CO2	O2	N2	TDCG	Cond	Status	Flags
1	2024-08-07	Laboratory 1	28	8	2	9	0	451	1,874	1,412	64,190	498	2	1	
2	2024-11-12	Laboratory 1	30	8	1	9	0	457	1,903	2,296	68,715	505	2	1	
3	2025-05-14	Laboratory 1	0	2	0	4	0	72	1,163	26,610	58,140	78	1	1	
4	2025-07-07	Laboratory 1	1	2	1	5	0	81	1,204	24,315	49,870	90	1	1	
5	2025-10-29	Laboratory 1	3	2	1	6	0	98	1,227	24,980	54,760	110	1	1	
6	2026-02-03	Laboratory 1	0	2	1	9	0	201	1,551	23,940	73,655	213	1	1	
7	2026-05-05	Laboratory 1	53	284	92	618	7	589	2,259	5,717	70,334	1,643	4	—	Questionable: retest did not repeat it; Matches another unit
8	2026-05-22	Laboratory 2	7	3	1	13	0	226	2,231	23,860	72,780	250	1	1	Lab change

Amber: above the C57.104-2019 Table 1 norm. Red: questionable sample. Cond: IEEE Std. C57.104-2008 condition. Status: IEEE Std. C57.104-2019 DGA status.

Sample quality screening

#	Date	Finding	Evidence
7	2026-05-05	**Questionable: retest did not repeat it**	February 3, 2026 → May 5, 2026 → May 22, 2026: H2 0 → 53 → 7, CH4 2 → 284 → 3, C2H6 1 → 92 → 1, C2H4 9 → 618 → 13, C2H2 0 → 7 → 0 ppm.
7	2026-05-05	Matches another unit	All 9 gases within 12 % (H2 54 vs 53, CH4 273 vs 284, C2H6 91 vs 92, C2H4 607 vs 618 ppm).

UNIT 2 · IEEE STD. C57.104-2019

DGA Status 1

Sample 8, 2026-05-22. O2/N2 0.33: above 0.2 section. Age 23 years: 10-30 yr column. Rate from 6 samples over 556 days.

Gas	ppm	Table 1 norm	Table 2 norm	Change since 2026-02-03	Table 3 norm	Rate (ppm/yr)	Table 4 norm	Result
Hydrogen (H2)	7	40	90	+7	25	-12.8	10	Below
Methane (CH4)	3	20	60	+1	10	-2.8	3	Below
Ethane (C2H6)	1	15	40	0	7	+0.2	2	Below
Ethylene (C2H4)	13	60	125	+4	20	+3.1	5	Below
Acetylene (C2H2)	0	2	7	0	any increase	0.0	any rise	Below
Carbon monoxide (CO)	226	500	600	+25	175	-98.4	80	Below
Carbon dioxide (CO2)	2,231	5,500	8,000	+680	1,750	+220.0	800	Below

Result: the tables this gas reached. Below: below every norm that applies. Status 3 needs a gas above Table 2 or a rate above Table 4. Status 1 needs every gas, change and rate below its norm. Anything else is Status 2.

Status of each sample

#	Date	O2/N2	Section	Age column	Rate basis	Status	Confirmation	What took it out of Status 1
1	2024-08-07	0.02	0.2 or below	10-30 yr	—	1		
2	2024-11-12	0.03	0.2 or below	10-30 yr	—	1		
3	2025-05-14	0.46	above 0.2	10-30 yr	3 over 280 d	1		
4	2025-07-07	0.49	above 0.2	10-30 yr	4 over 334 d	1		
5	2025-10-29	0.46	above 0.2	10-30 yr	5 over 448 d	1		
6	2026-02-03	0.33	above 0.2	10-30 yr	6 over 545 d	1		
8	2026-05-22	0.33	above 0.2	10-30 yr	6 over 556 d	1		

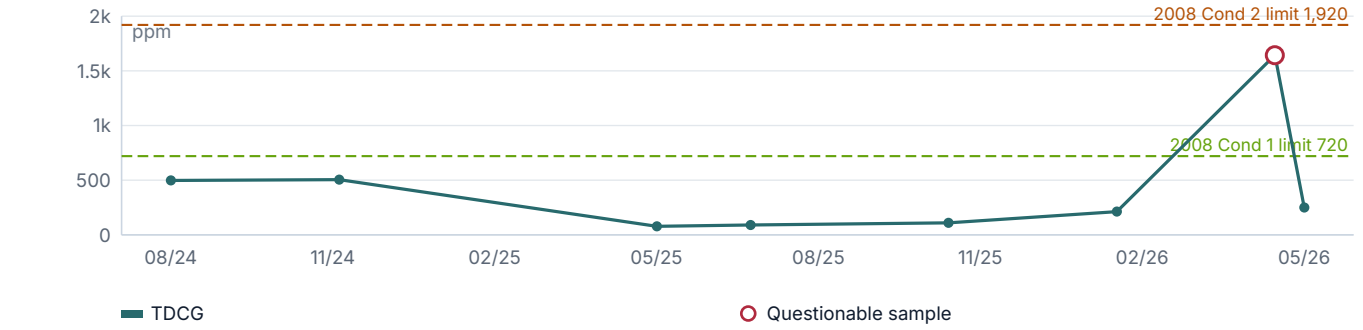
Samples marked questionable in the screening are left out. A status classifies the DGA result, not the condition of the transformer (§6.1). C57.104 is a guide and its norms are statistical (§5.4), so a result below them does not show a unit is free of faults. Owners may set their own norms, and an expert may consider a lower status when samples over a year or more show no active gassing (§6.1.2).

UNIT 2 · TRENDS

Dashed lines: IEEE C57.104-2008 Table 1 condition limits, for comparison with earlier reports. The 2019 edition keeps the 2008 method only as historical material in its Annex G. Dotted lines: IEEE C57.104-2019 Table 1 and Table 2 norms for the O2/N2 section and age of the latest trusted sample. TDCG has only the 2008 lines, because the 2019 edition does not use TDCG. "//" on the date axis marks a long gap between samples.

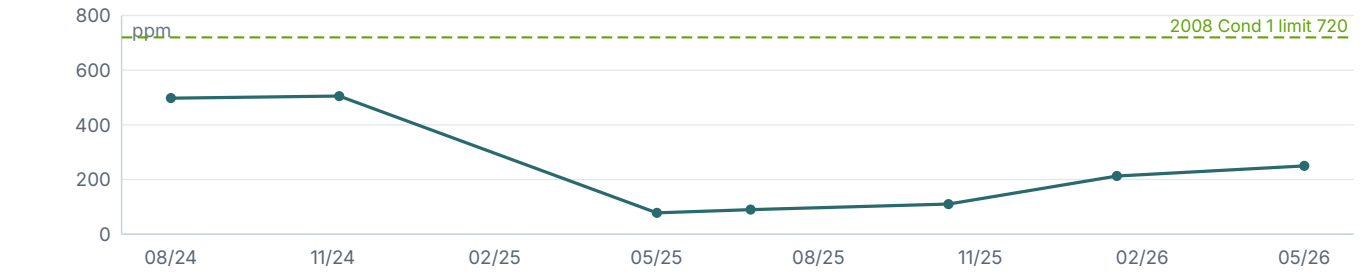
TDCG

All samples



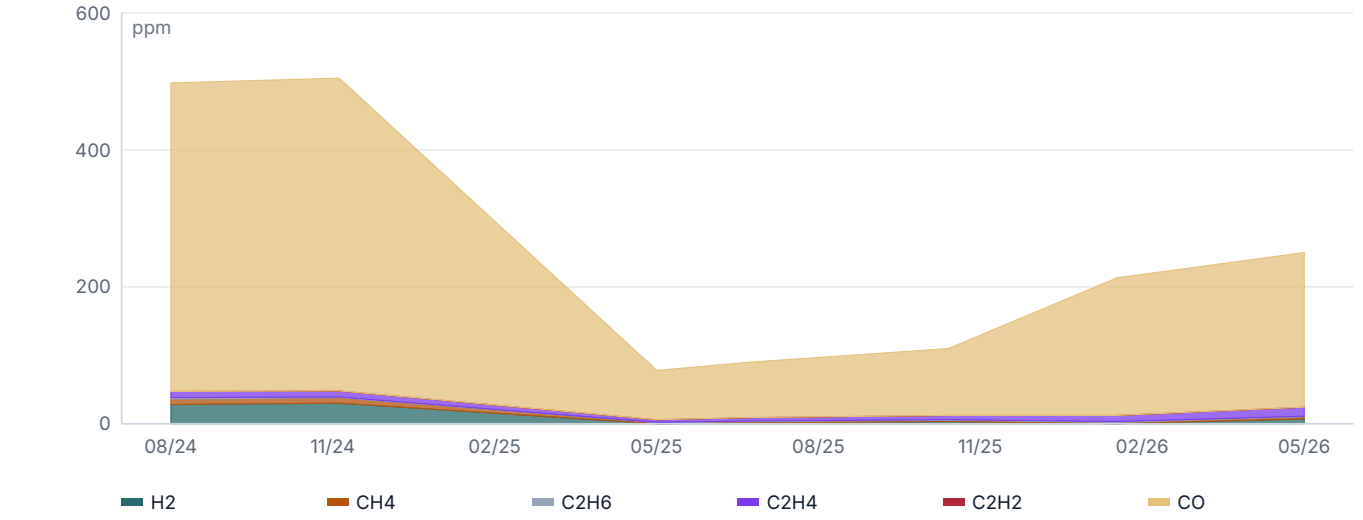
TDCG

Questionable samples removed



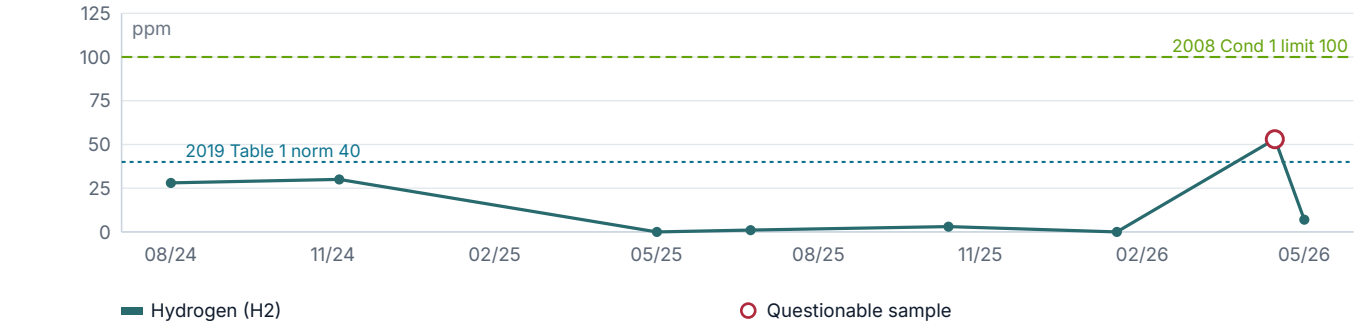
Combustible gases, stacked

One band per gas; the top edge is TDCG · questionable samples removed · IEEE C57.104-2019 §5.3.3



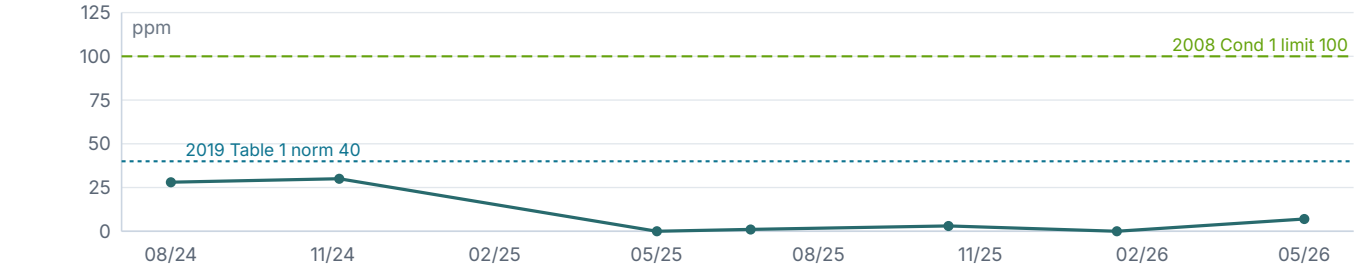
Hydrogen (H2)

All samples



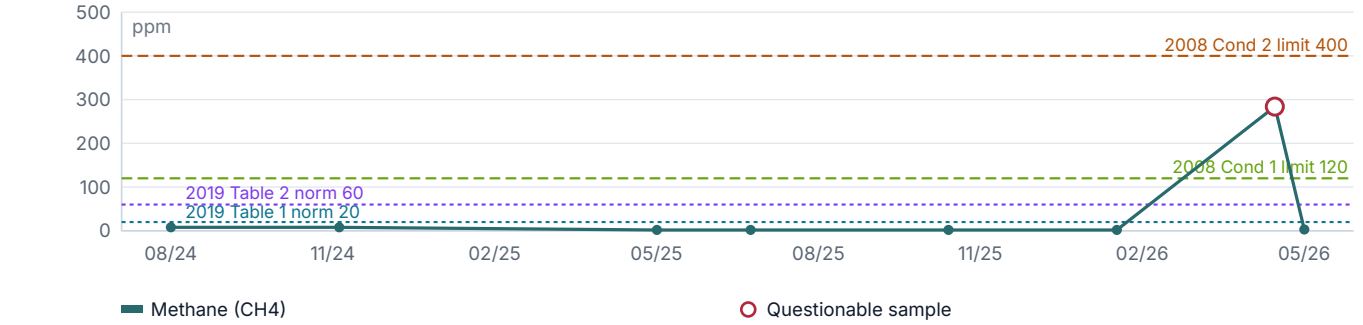
Hydrogen (H2)

Questionable samples removed



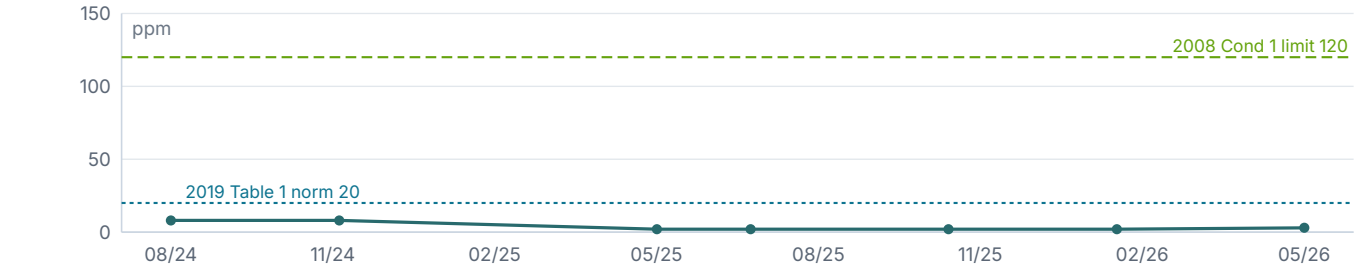
Methane (CH4)

All samples



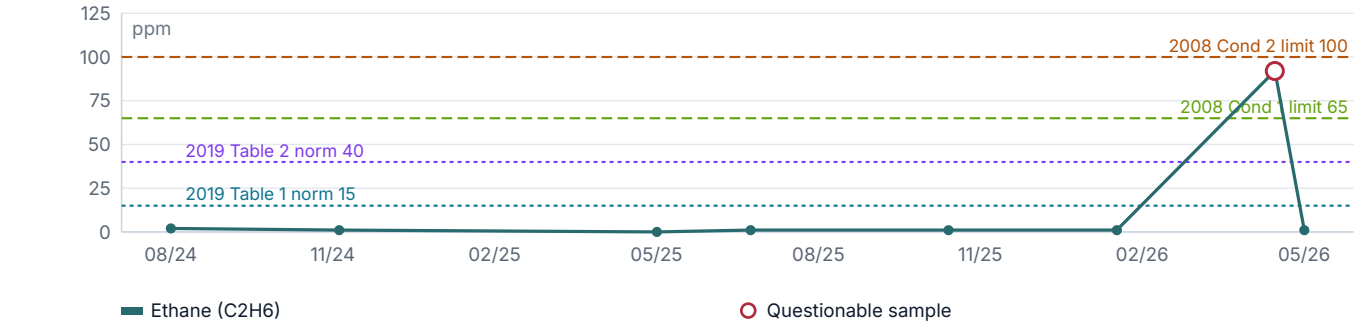
Methane (CH4)

Questionable samples removed



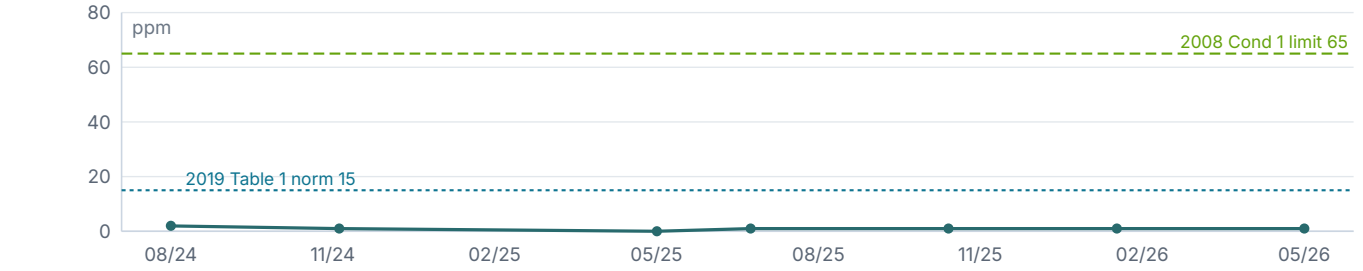
Ethane (C2H6)

All samples



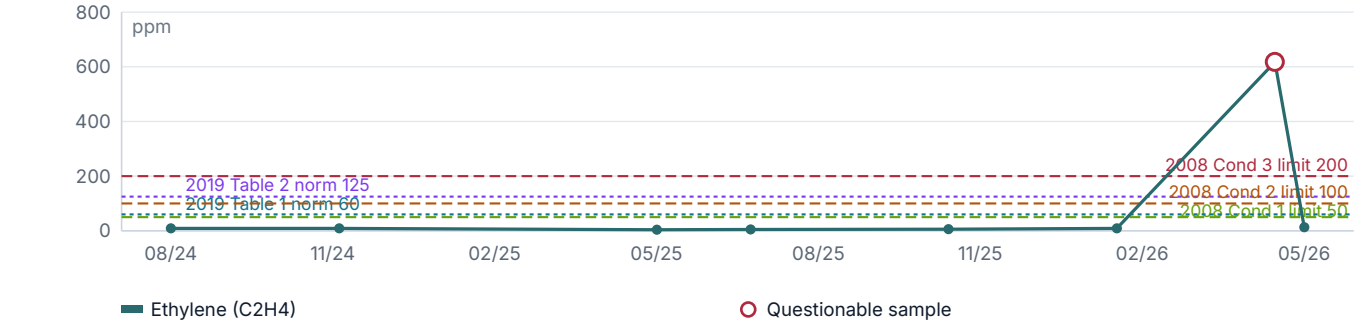
Ethane (C2H6)

Questionable samples removed



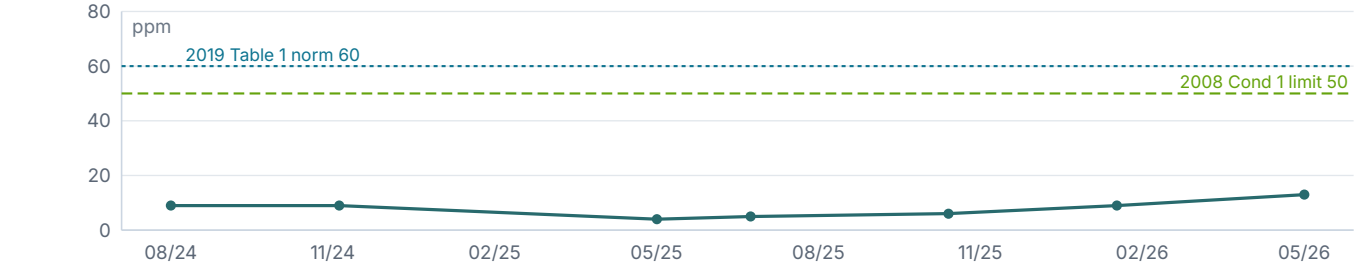
Ethylene (C2H4)

All samples



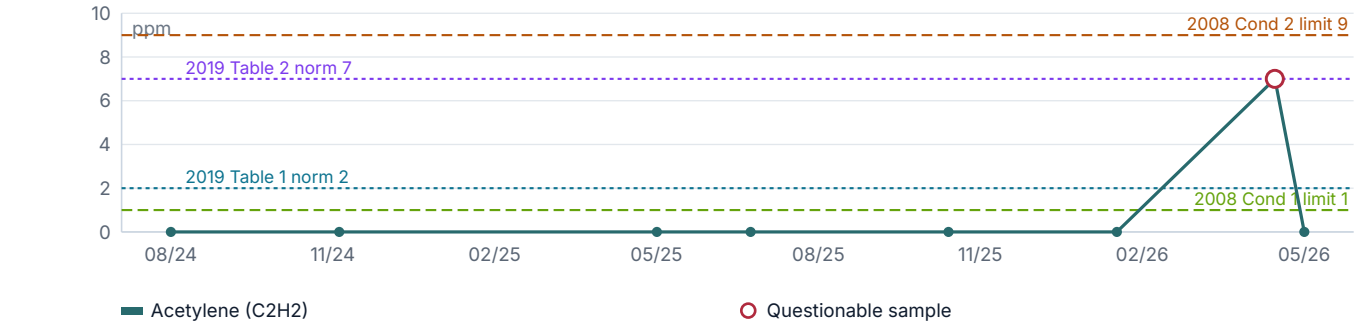
Ethylene (C2H4)

Questionable samples removed



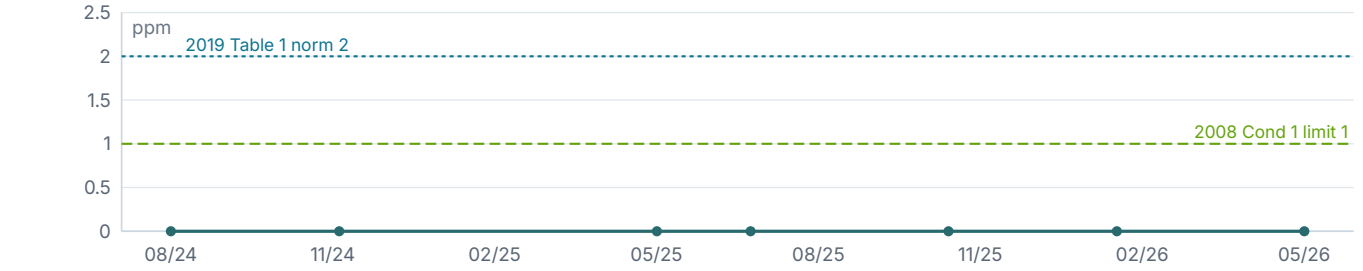
Acetylene (C2H2)

All samples



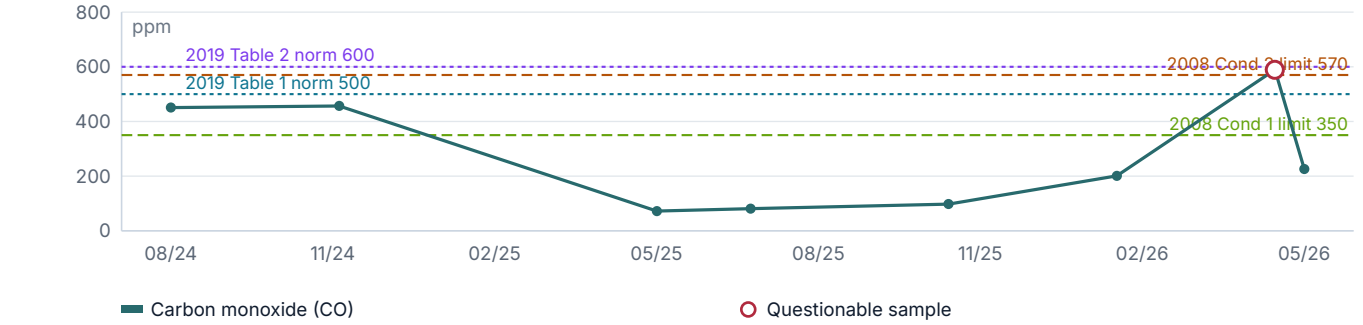
Acetylene (C2H2)

Questionable samples removed



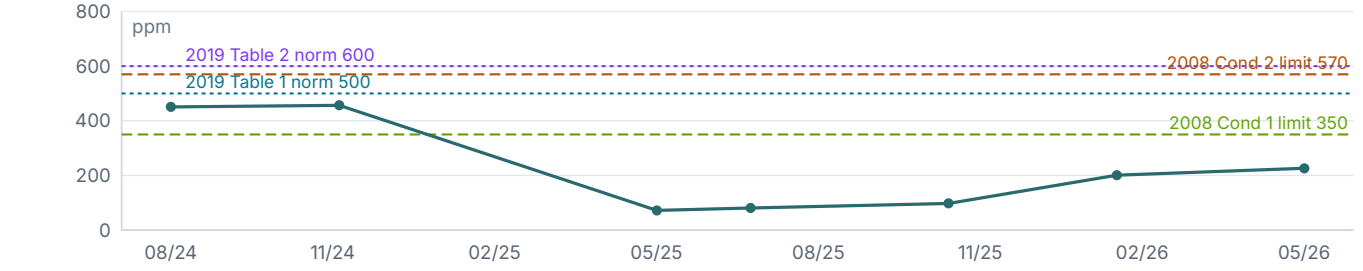
Carbon monoxide (CO)

All samples



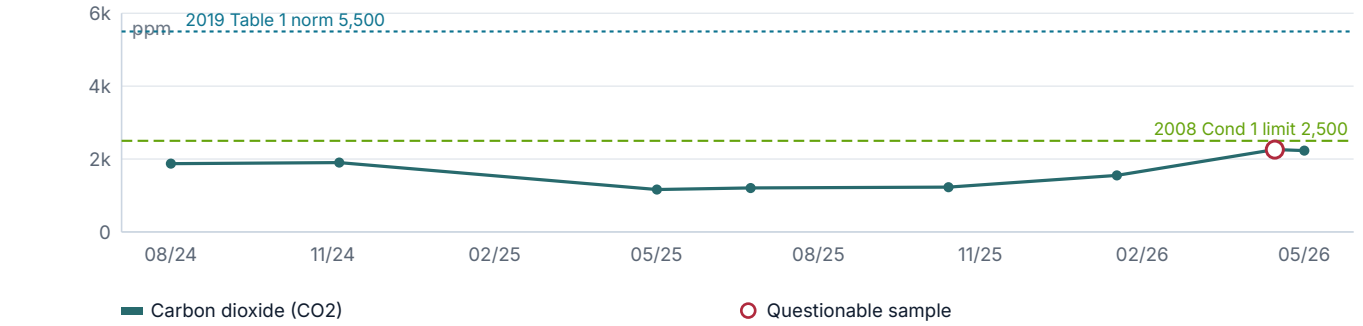
Carbon monoxide (CO)

Questionable samples removed



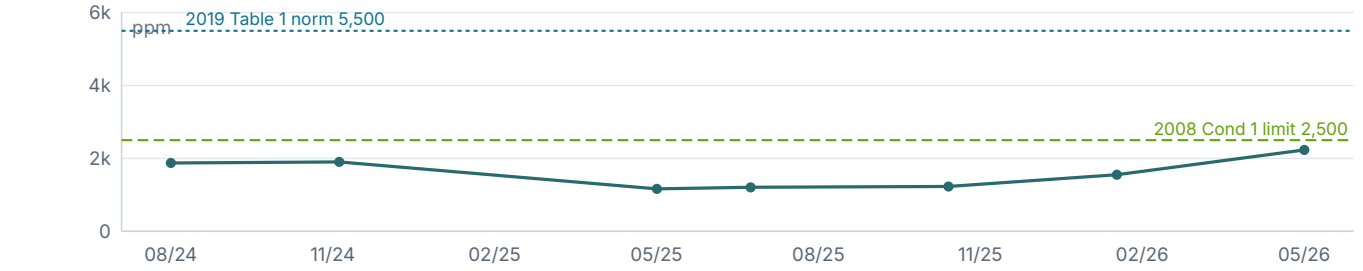
Carbon dioxide (CO2)

All samples



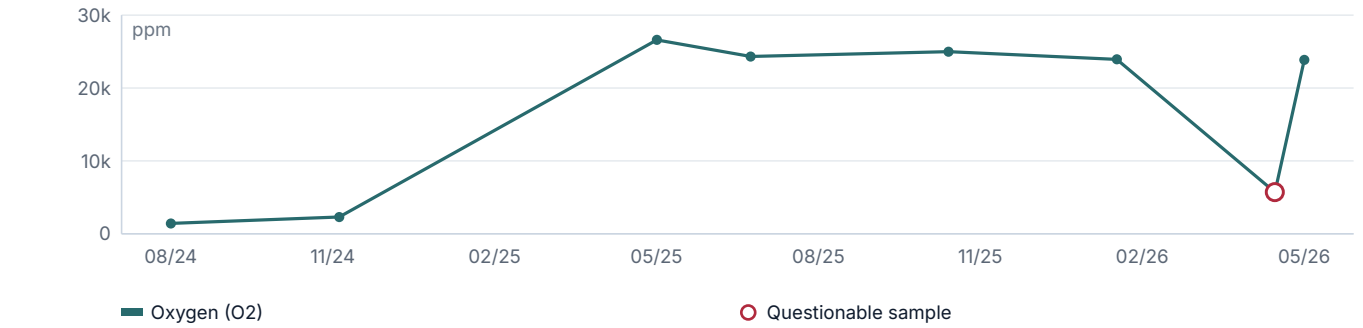
Carbon dioxide (CO2)

Questionable samples removed



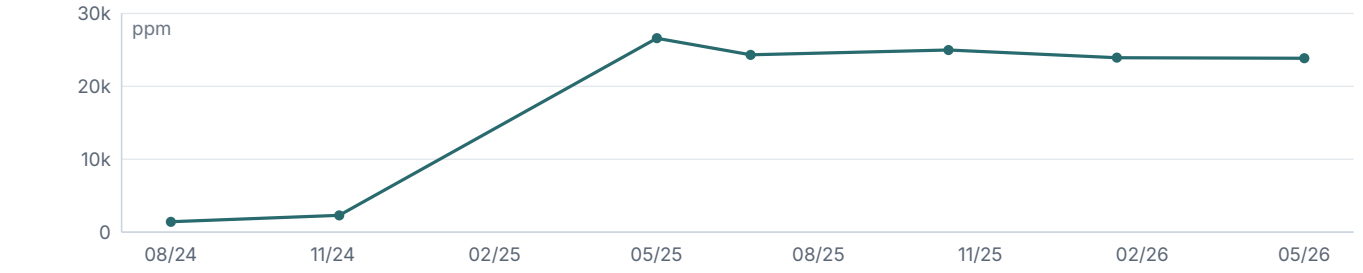
Oxygen (O2)

All samples



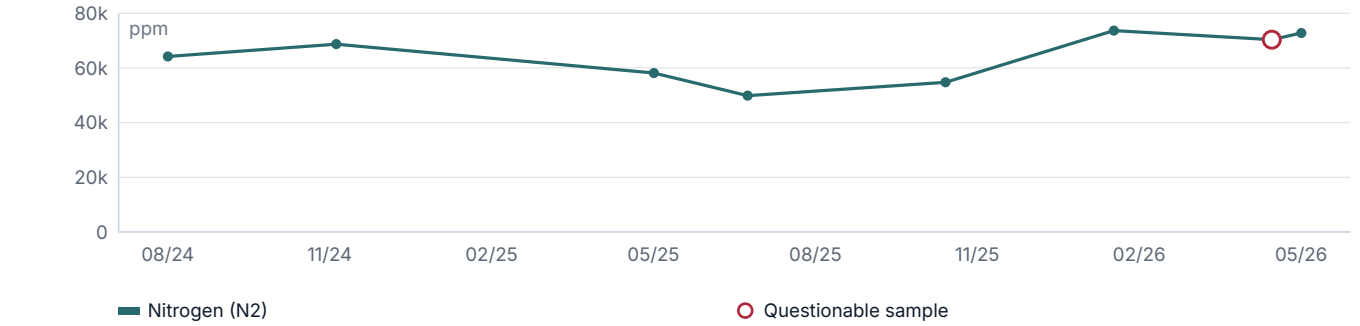
Oxygen (O2)

Questionable samples removed



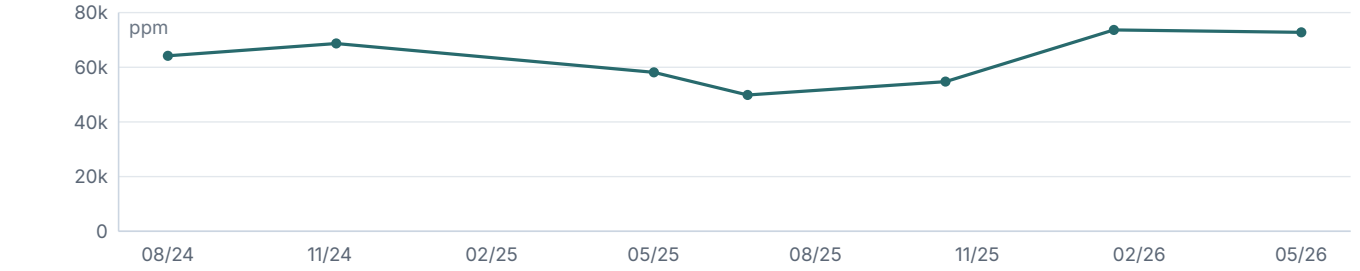
Nitrogen (N2)

All samples



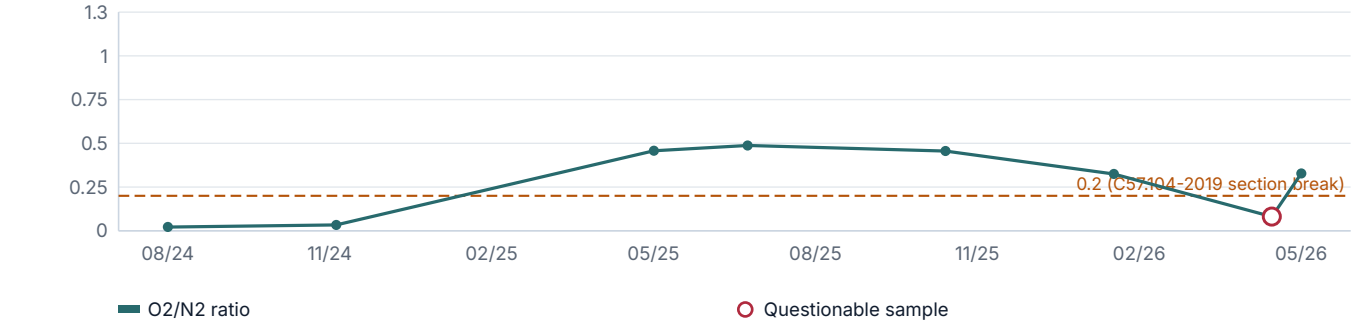
Nitrogen (N2)

Questionable samples removed



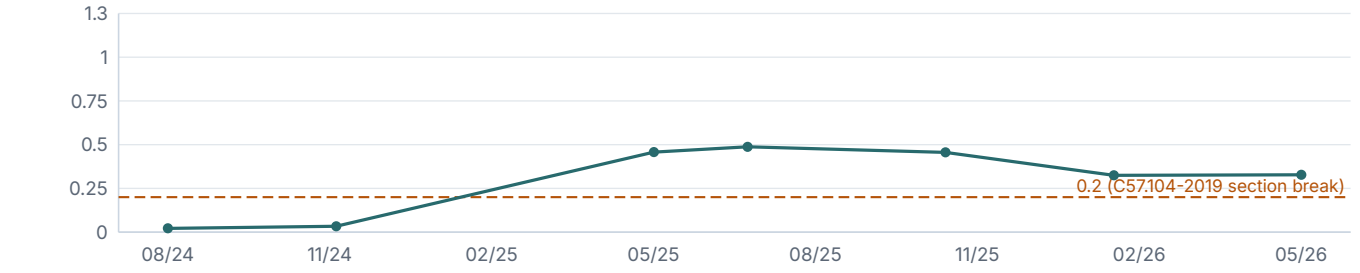
O2/N2 ratio

All samples



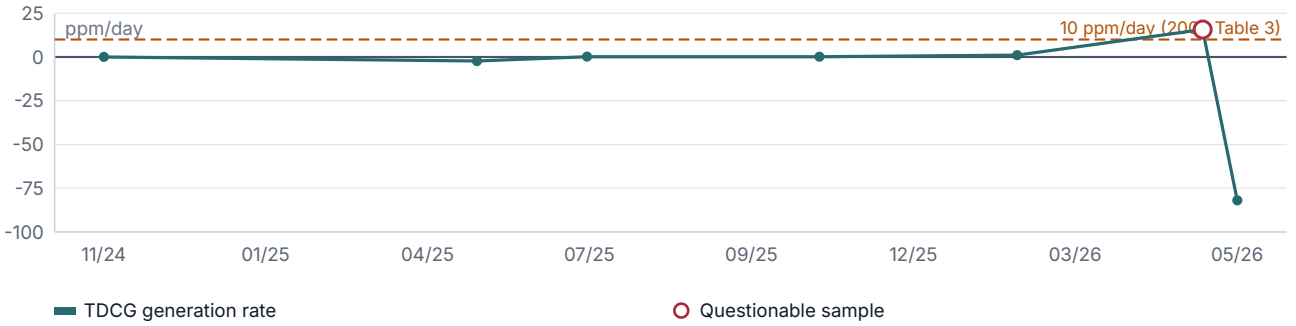
O2/N2 ratio

Questionable samples removed



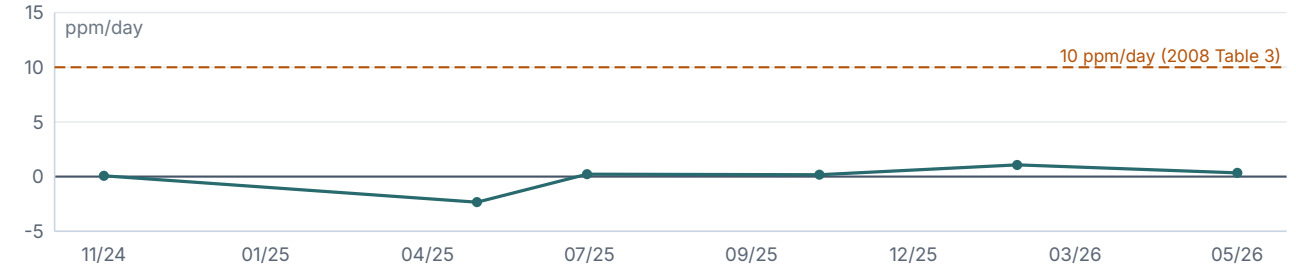
TDCG generation rate

All samples



TDCG generation rate

Questionable samples removed



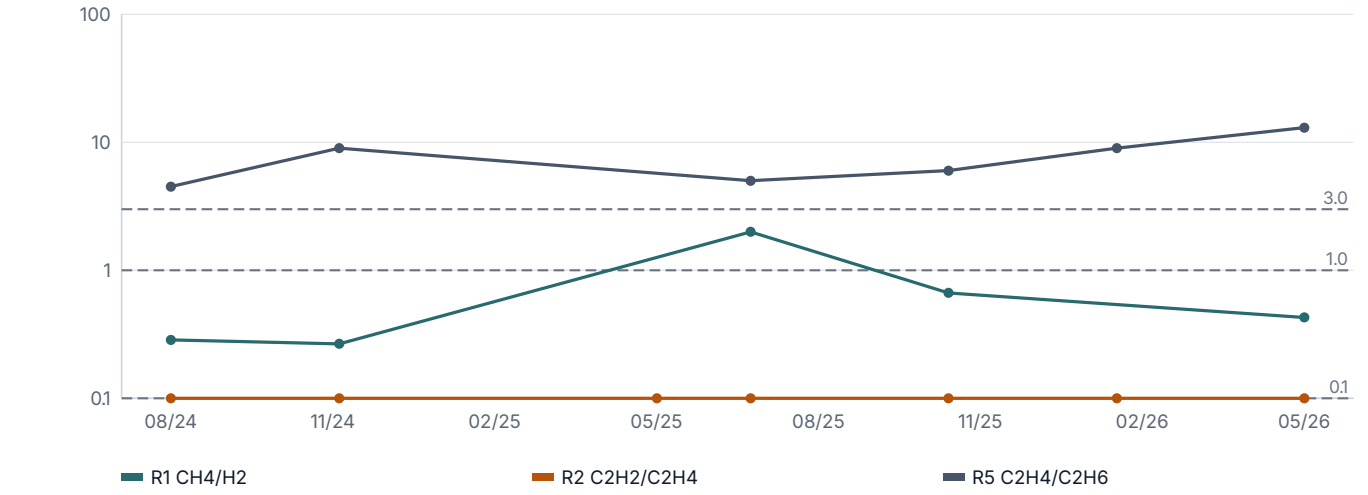
UNIT 2 · RATIO METHODS

R1 = CH4/H2, R2 = C2H2/C2H4, R5 = C2H4/C2H6. Gray rows are within Condition 1 and DGA Status 1, where the ratios are not diagnostic.

#	Date	R1	R2	R5	Rogers case	IEC code	Key Gas	CO2/CO	NEI-HC	NEI-CO	Cond	
1	2024-08-07	0.29	0.00	4.50	No case	002 Code not in the diagnosis table	overheated cellulose	4.16	0.08	4.57	2	
2	2024-11-12	0.27	0.00	9.00	No case	002 Code not in the diagnosis table	overheated cellulose	4.16	0.07	4.63	2	
3	2025-05-14	∞	0.00	∞	5: Thermal fault above 700 °C	022 Thermal fault above 700 °C	—	16.2	0.03	1.89	1	
4	2025-07-07	2.00	0.00	5.00	5: Thermal fault above 700 °C	022 Thermal fault above 700 °C	—	14.9	0.03	1.99	1	
5	2025-10-29	0.67	0.00	6.00	No case	002 Code not in the diagnosis table	—	12.5	0.04	2.10	1	
6	2026-02-03	∞	0.00	9.00	5: Thermal fault above 700 °C	022 Thermal fault above 700 °C	—	7.72	0.05	3.00	1	
7	2026-05-05	5.36	0.01	6.72	5: Thermal fault above 700 °C	022 Thermal fault above 700 °C	overheated oil	3.84	4.33	5.71	4	questionable
8	2026-05-22	0.43	0.00	13.0	No case	002 Code not in the diagnosis table	—	9.87	0.07	4.03	1	latest trusted

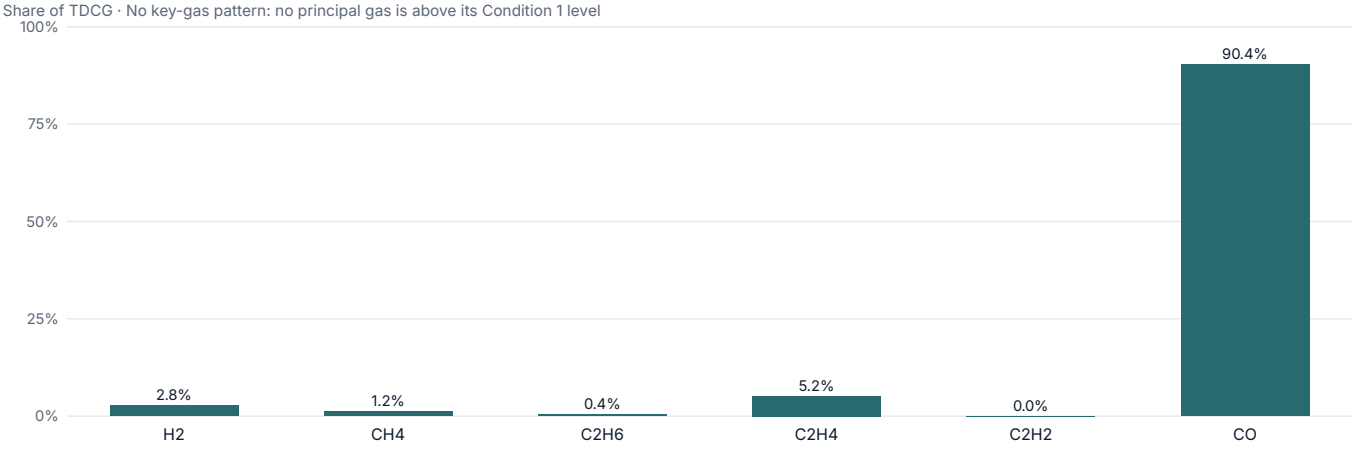
Rogers ratios R1, R2, R5

Questionable samples removed · log scale



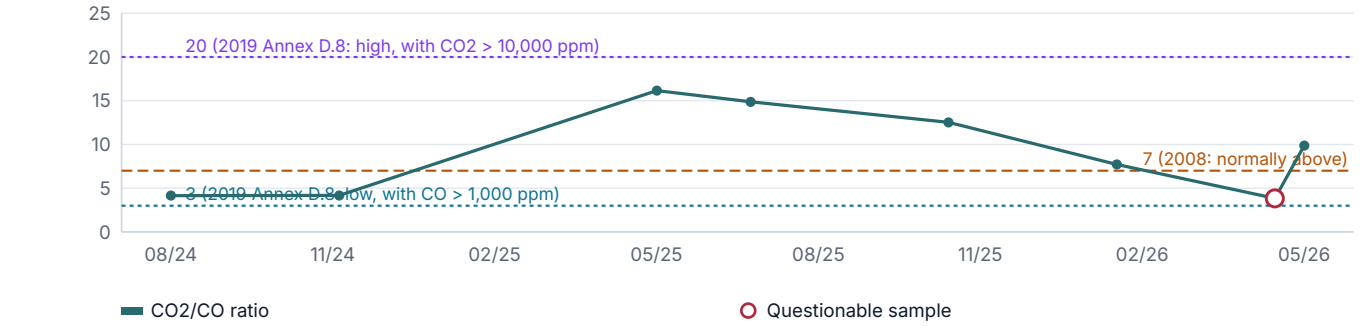
Key Gas, sample 8 (2026-05-22)

Share of TDCG · No key-gas pattern: no principal gas is above its Condition 1 level



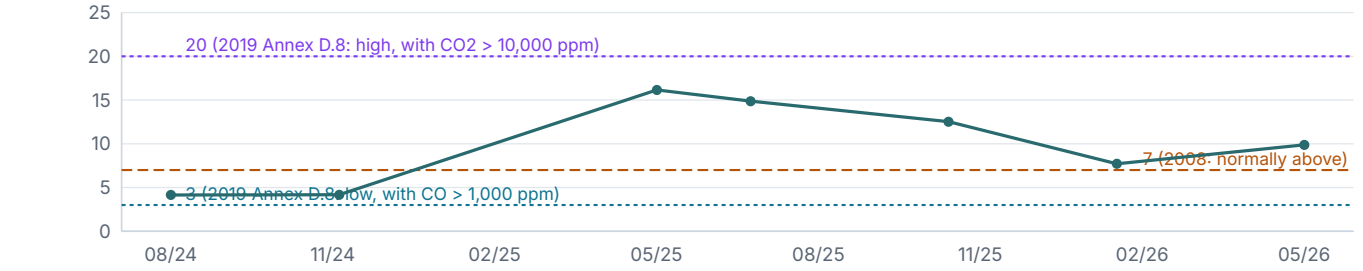
CO2/CO ratio

All samples



CO2/CO ratio

Questionable samples removed

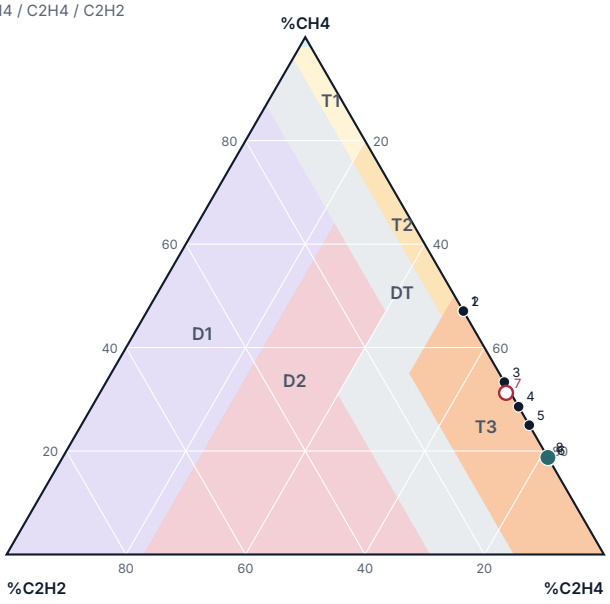


UNIT 2 · DUVAL TRIANGLES AND PENTAGONS

Numbers match the results table. Teal: latest trusted sample. Hollow red: questionable. Triangle 4 applies to T1 results and Triangle 5 to T2/T3, but all samples are plotted.

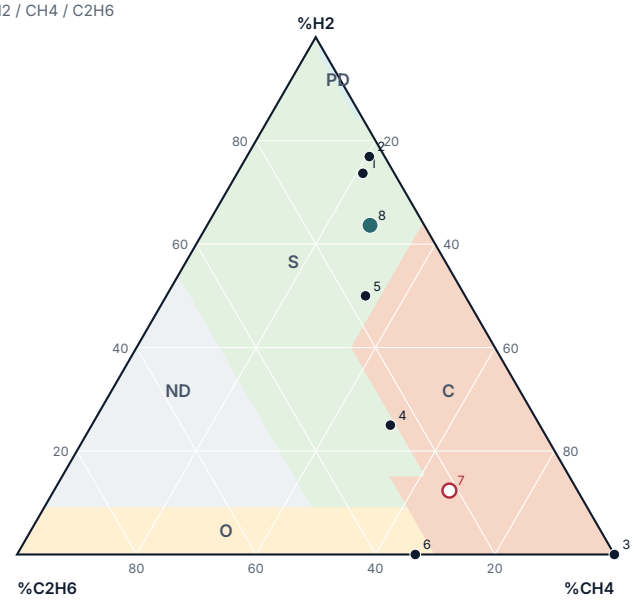
Duval Triangle 1

CH4 / C2H4 / C2H2



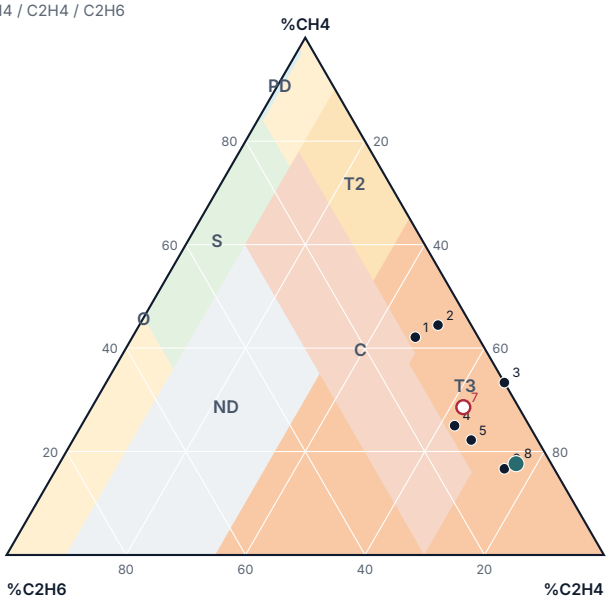
Duval Triangle 4 (low-temperature faults)

H2 / CH4 / C2H6



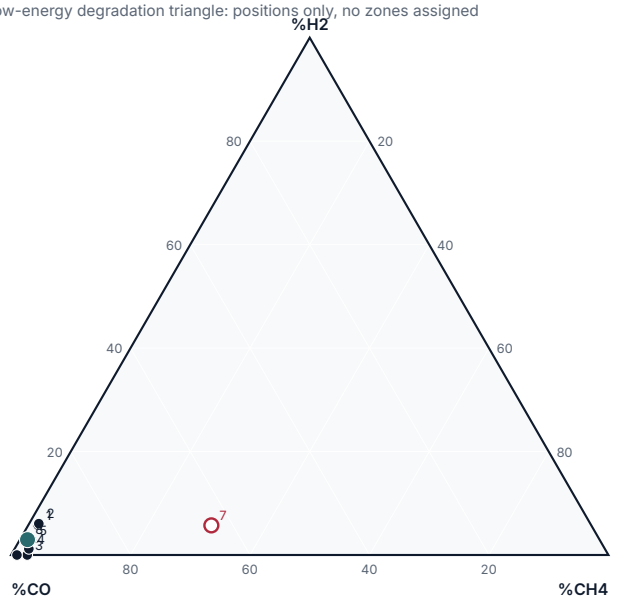
Duval Triangle 5 (high-temperature faults)

CH4 / C2H4 / C2H6



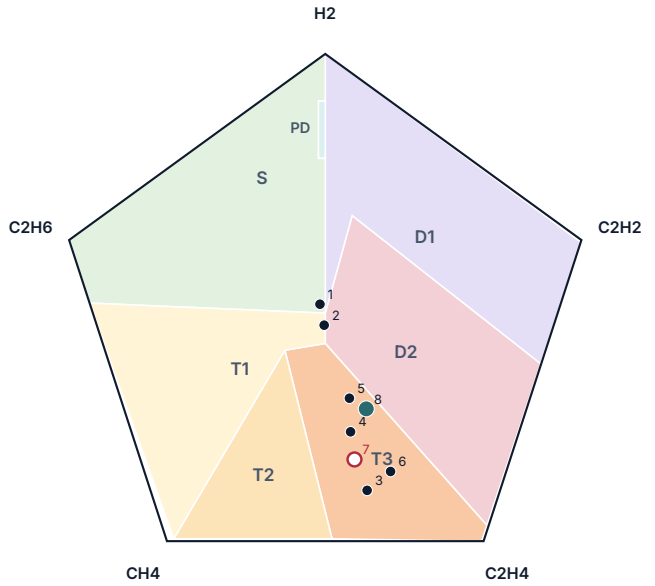
LEDT (H2 / CO / CH4)

Low-energy degradation triangle: positions only, no zones assigned



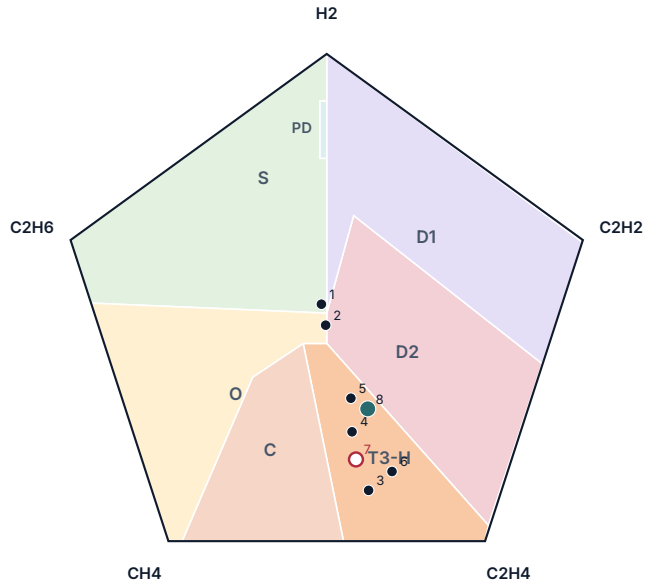
Duval Pentagon 1

Centroid of the H2, CH4, C2H2, C2H4 and C2H6 pentagon



Duval Pentagon 2

Same point; zones separate oil-only T3 from paper carbonization



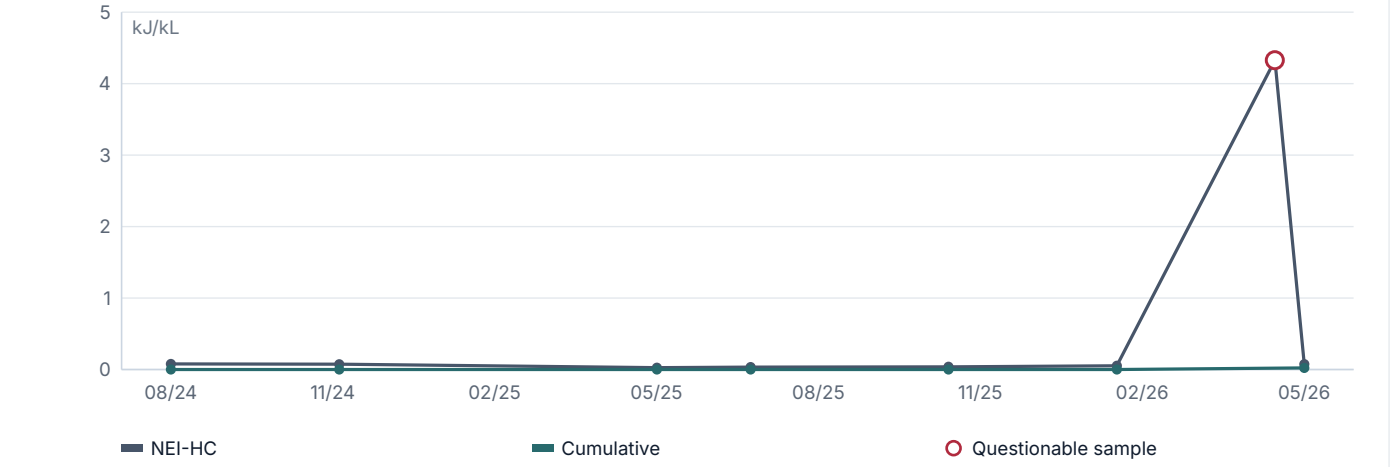
#	Date	Triangle 1	Triangle 4	Triangle 5	Pentagon 1	Pentagon 2
1	2024-08-07	T3: thermal fault above 700 °C	S	T3	S	S
2	2024-11-12	T3: thermal fault above 700 °C	S	T3	T1	O
3	2025-05-14	T3: thermal fault above 700 °C	C	T3	T3	T3-H
4	2025-07-07	T3: thermal fault above 700 °C	S	T3	T3	T3-H
5	2025-10-29	T3: thermal fault above 700 °C	S	T3	T3	T3-H
6	2026-02-03	T3: thermal fault above 700 °C	O	T3	T3	T3-H
7	2026-05-05	T3: thermal fault above 700 °C	C	T3	T3	T3-H
8	2026-05-22	T3: thermal fault above 700 °C	S	T3	T3	T3-H

UNIT 2 · RELIABILITY-BASED INDICATORS

NEI weights each gas by the energy it takes to form (Jakob and Dukarm, 2015; IEEE C57.104-2019 Annex F): one number for oil gases, one for paper gases. The cumulative line only counts increases, so gas lost to leaks or degassing does not hide earlier gassing. Annex F reports that one utility treats an NEI-HC increase of 0.5 kJ/kL over any interval as cause for concern.

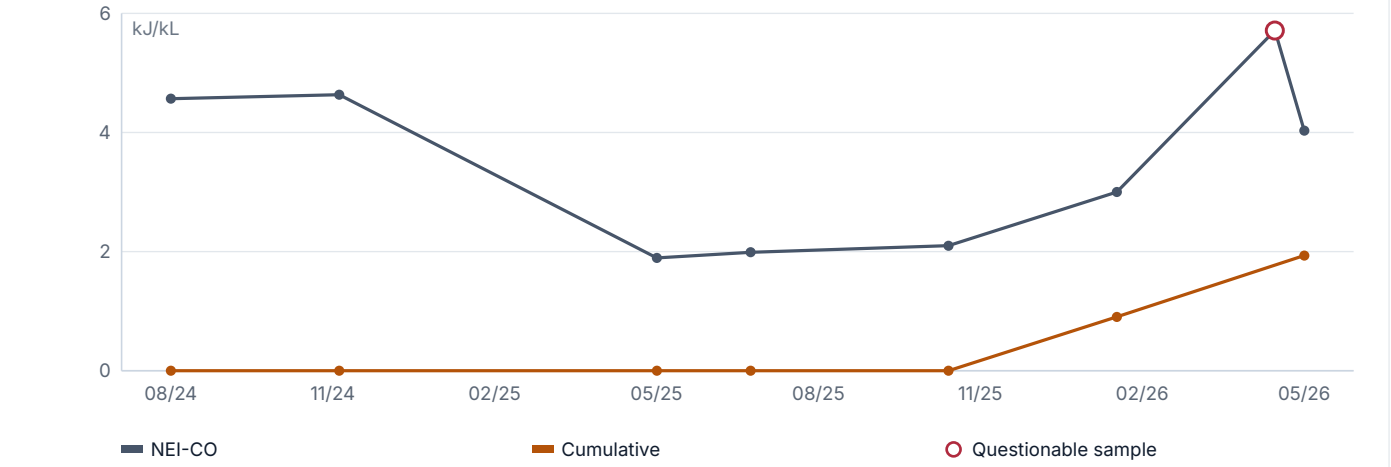
NEI-HC (oil)

Per sample and cumulative



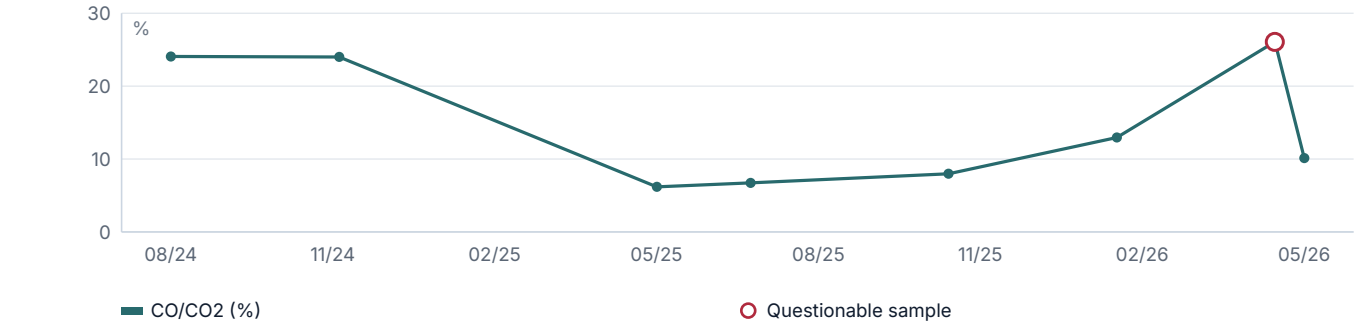
NEI-CO (paper)

Per sample and cumulative



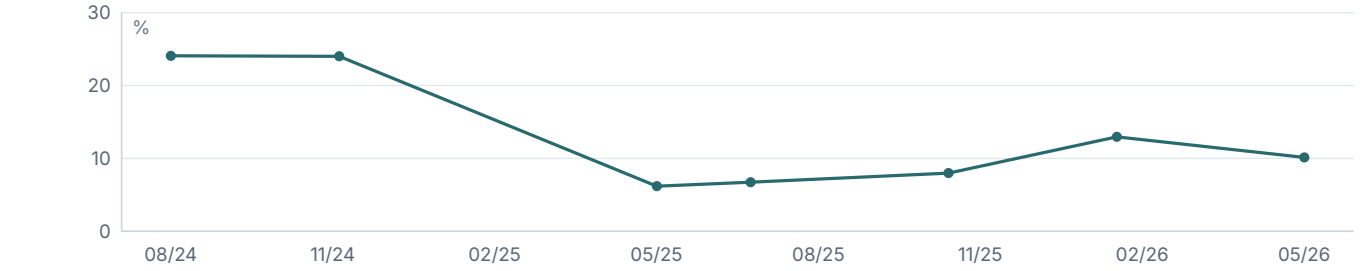
CO/CO2 (%)

All samples



CO/CO2 (%)

Questionable samples removed



Gassing events

Index	From	To	Increase (kJ/kL)	Interpretation
NEI-CO	2025-10-29	2026-05-22	1.93	CO/CO2 +27 %. The change is too small to indicate where paper is being heated.

METHODS AND REFERENCES

Methods

Data: an AI model copied the gas values, dates and nameplate data from each lab report. Lab totals are checked against the copied gases; a mismatch holds the report for review. Everything after that is fixed code.

DGA status: IEEE Std. C57.104-2019 Tables 1 to 4, Figure 2 and §6.1.1. The section comes from the sample's O2/N2. No usable ratio, or a ratio crossing 0.2 twice or more in the last 6 samples, takes the above-0.2 section. The column comes from the manufacture year on the lab report, and a unit in its first year takes the 1-9 column. Change is from the previous trusted sample, and only an increase counts. Rate is a linear fit through the last 3 to 6 trusted samples over more than 4 months and less than 2 years. If the last 6 span under 4 months, earlier samples are added until they span 4 months. A rate period past 9 months takes the 10-24 month column of Table 4. A value equal to a norm is not Status 1. A jump the next sample does not confirm, and mostly undoes, is left out of later rates. Oil processing starts a new series.

Condition and sampling: IEEE Std. C57.104-2008 Table 1 (highest condition of any gas or TDCG) and Table 3 (TDCG rate between the two latest trusted samples). Shown for comparison with earlier reports; the 2019 edition keeps this method only as historical material in its Annex G.

Fault type: with C57.104-2019 leading, no fault type is named when every gas is below its Table 1 norm (§5.2.1). When CH4, C2H4 or C2H2 changed by its Table 3 norm since the previous trusted sample, the added gas is also zoned on Triangle 1, with decreases counted as zero (Annex D.6). Triangle 1 and Pentagon 1 pointing to different kinds of fault (thermal and electrical) is reported as a possible mixed fault. O2/N2 at least 30 % below the highest of the previous five trusted samples is reported as support for a thermal fault (Annex D.9.1). C2H2/H2 above 3 is reported as possible tap-changer oil (Annex D.9.2).

Carbon oxides: with C57.104-2019 leading, CO above 1,000 ppm or CO2/CO below 3 is read per Annex D.8: as oil oxidation without hydrocarbons above Table 1, as possible paper involvement with them, and CO2 above 10,000 ppm with CO2/CO above 20 as slow paper aging. With C57.104-2008 leading, CO2/CO below 7 is read per its §5.1.

Ratios: Rogers per C57.104-2008 Table 6; IEC three-ratio code. Key Gas per §6.6, only when the main gas is above Condition 1.

Duval Triangles 1, 4, 5 and Pentagons 1, 2: rules and zone outlines taken from Duval's own workbooks and checked against them. They can differ slightly from the figures and coordinates printed in IEEE Std. C57.104-2019 Annex D. Pentagon gases below 0.1 ppm count as 0.1 ppm.

NEI-HC = (77.7 CH4 + 93.5 C2H6 + 104.1 C2H4 + 278.3 C2H2) / 22,400; NEI-CO = (101.4 CO + 30.2 CO2) / 22,400, in kJ/kL (Jakob and Dukarm, 2015; IEEE Std. C57.104-2019 Annex F).

Questionable sample: a gas at 3× the last trusted sample that the next sample does not repeat. A jump in the latest sample is kept and flagged for retest. Air in sample: O2 or N2 at 3× its neighbors. Oil processing: TDCG, CO2 and N2 all down 60 % at once. Two units within 12 % on every gas within 3 days: possible mix-up.

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