

Analysis Preview

Review of results to date from
analysis of DGA database

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Thank You

- Michel Duval
- Norman Field
- Luiz Cheim
- Lan Lin
 - For the tremendous work done to date on data analysis
- All anonymous data suppliers
 - To give us the opportunity to answer old questions

C57.104 Table 1

What was the choice for limits?

Table 1—Dissolved gas concentrations

Status	Dissolved key gas concentration limits [$\mu\text{L/L}$ (ppm) ^a]							
	Hydrogen (H ₂)	Methane (CH ₄)	Acetylene (C ₂ H ₂)	Ethylene (C ₂ H ₄)	Ethane (C ₂ H ₆)	Carbon monoxide (CO)	Carbon dioxide (CO ₂)	TDCG ^b
Condition 1	100	120	1	50	65	350	2 500	720
Condition 2	101–700	121–400	2–9	51–100	66–100	351–570	2 500–4 000	721–1920
Condition 3	701–1800	401–1000	10–35	101–200	101–150	571–1400	4 001–10 000	1921–4630
Condition 4	>1800	>1000	>35	>200	>150	>1400	>10 000	>4630

NOTE 1—Table 1 assumes that no previous tests on the transformer for dissolved gas analysis have been made or that no recent history exists. If a previous analysis exists, it should be reviewed to determine if the situation is stable or unstable. Refer to 6.5.2 for appropriate action(s) to be taken.

NOTE 2—An ASTM round-robin indicated variability in gas analysis between labs. This should be considered when having gas analysis made by different labs.

C57.104 Table 1

What was the choice for limits?

- Personal Experience ?
- One user database analysis ?
- Consensus from early users ?
- Lab recommendation ?
- Early mention in 1978 of 90% “probability norms” for some levels (now limit condition 1)
- 1991 mention for table 1 “Consensus values based on the experience of many company”

C57.104 Table 1

What was the choice for limits?

- Condition 1: $< 90\%$ of DGA population?
 - Condition 2: 90% to 95% ?
 - Condition 3: 95% to 99% ?
 - Condition 4: $> 99\%$?
-
- We are using these values for analysis purpose only

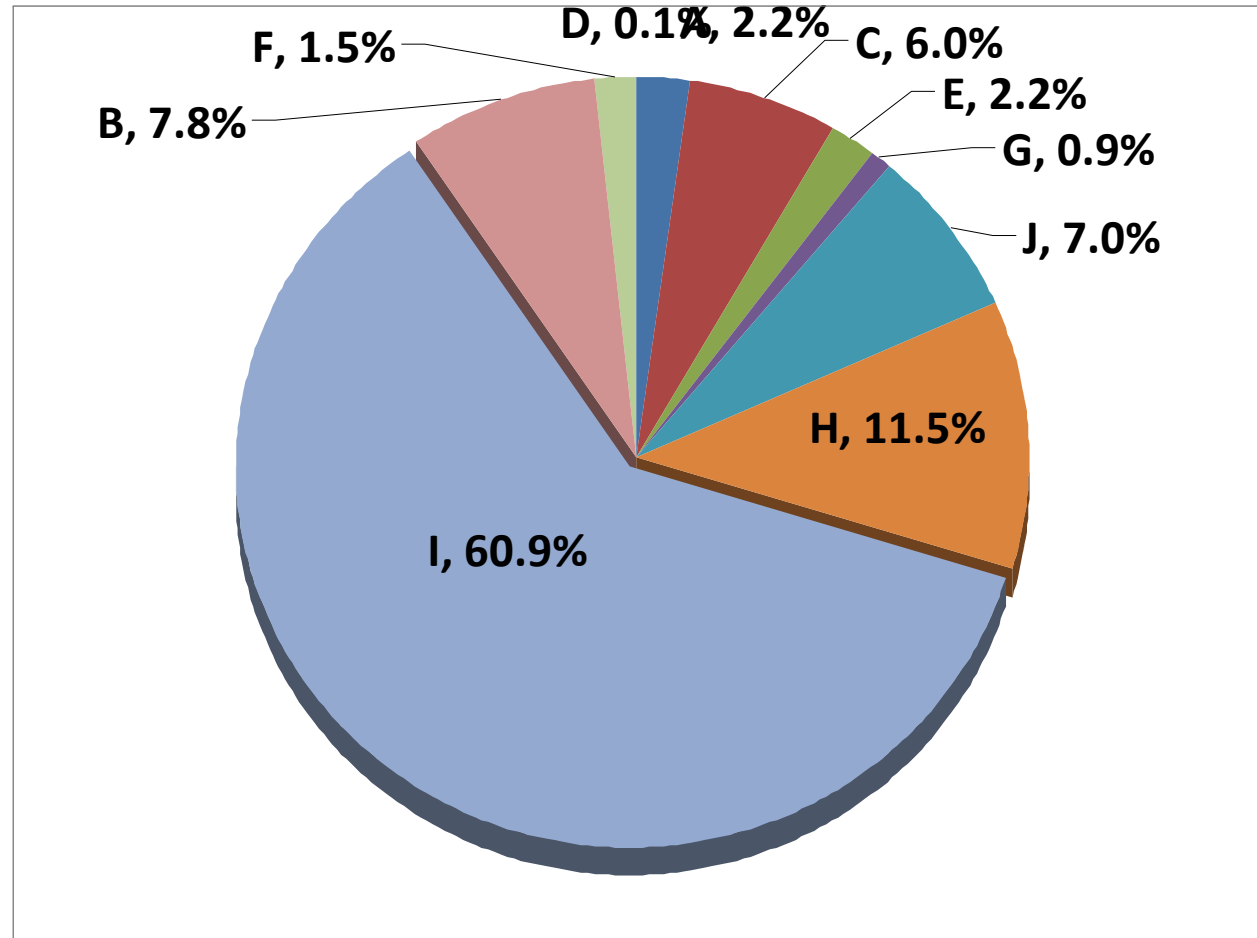
Process of data analysis

- Database filtered to remove inconsistent entries
 - Obvious error
 - Missing important information
 - Non transformer
 -
- Population curve computed for each gas and each studied condition
 - 90% to 99.5% population value used for evaluation

Source of data

479,191
Samples

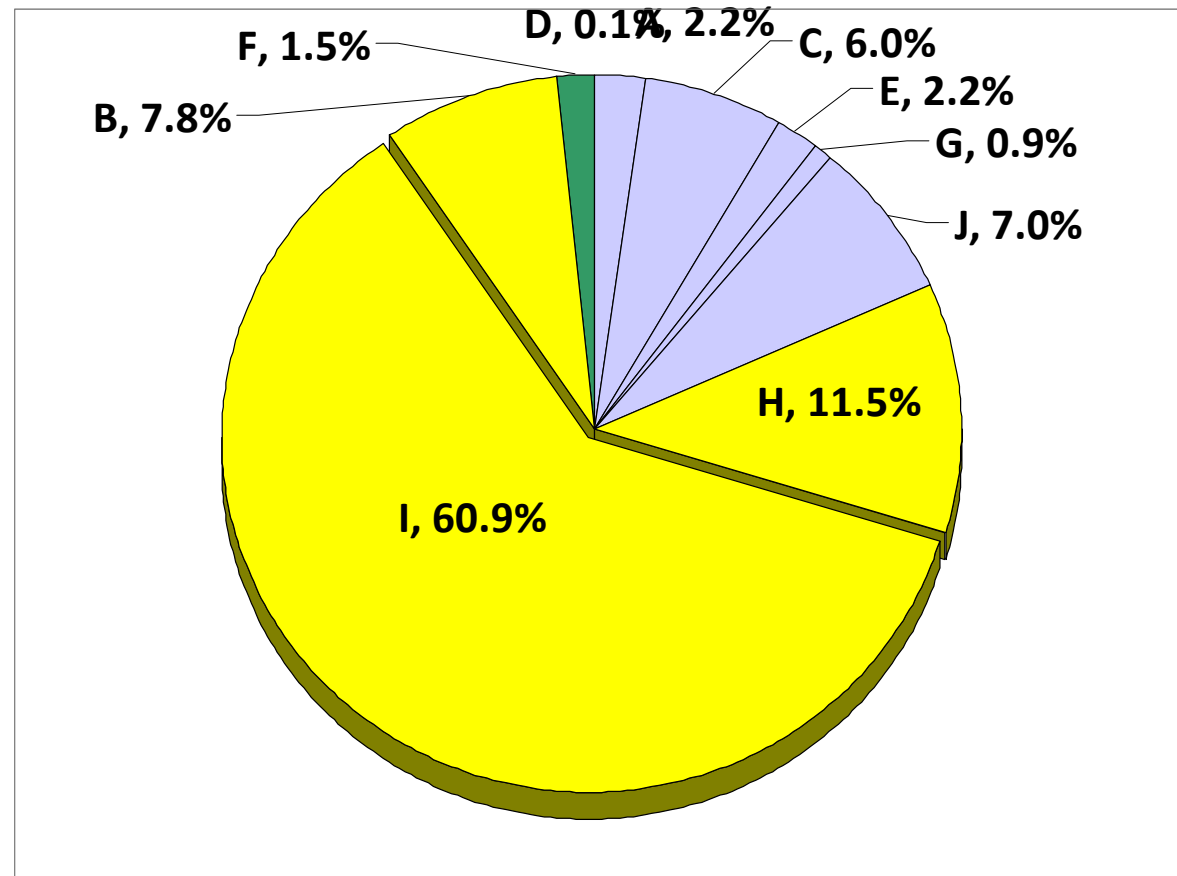
A	Utility
B	Lab
C	Utility
D	Industrial User
E	Utility
F	Insurance Co.
G	Utility
H	Lab
I	Lab
J	Utility



Source of data

479,191
Samples

A	Utility
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Data analysis

- Values proposed need to be sound from a statistic point of view
- Original data used to set table 1 is unavailable
- Comparison between table 1 and actual data indicate a mix of good and poor correlation using the 90, 95 and 99% hypothesis
- **CAUTION: LARGE DISPERSION OF RESULTS**

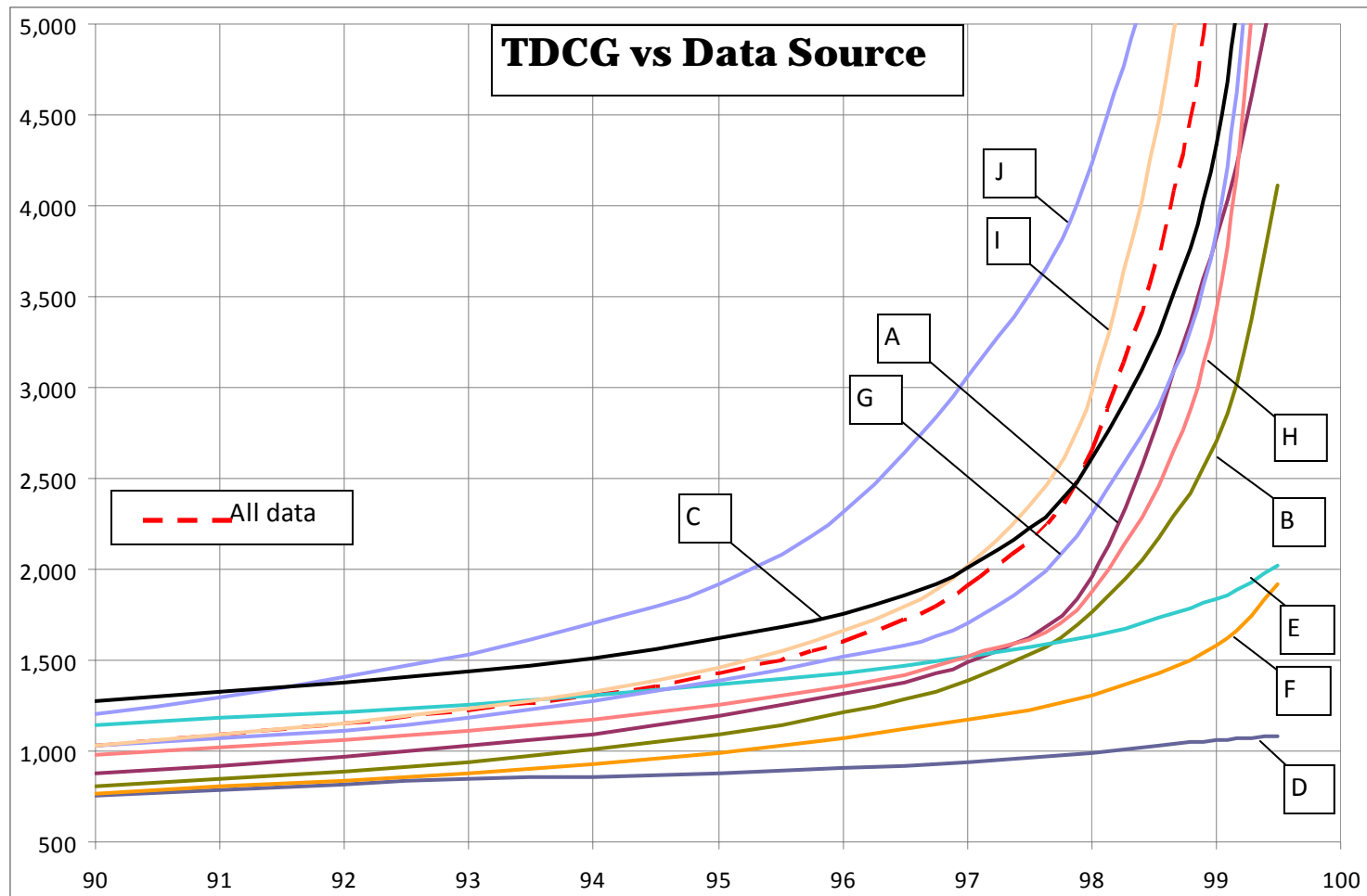
Table 1 VS Percentile, All data

Condition	H2	CH4	C2H2	C2H4	C2H6	CO	CO2	TDCG
1 - 2	100	120	1	50	65	350	2500	720
2 - 3	700	400	10	100	100	570	4000	1920
3 - 4	1800	1000	35	200	150	1400	10000	4630

Percentile	H2	CH4	C2H2	C2H4	C2H6	CO	CO2	TDCG
90	93	85	1	56	92	717	7491	1034
95	215	162	5	124	191	912	10223	1429
99	1706	869	78	1124	600	1386	18435	5439

Delta %	H2	CH4	C2H2	C2H4	C2H6	CO	CO2	TDCG
90	-7%	-29%	0%	12%	42%	105%	200%	44%
95	-69%	-60%	-50%	24%	91%	60%	156%	-26%
99	-5%	-13%	123%	462%	300%	-1%	84%	17%

Example of data dispersion



Problematic of data analysis

- Dispersion between sources is large
 - Different Network?
 - Different History?
 - Different Utilisation?
 - Different Laboratories?
- This fact must be taken into account during the analysis process

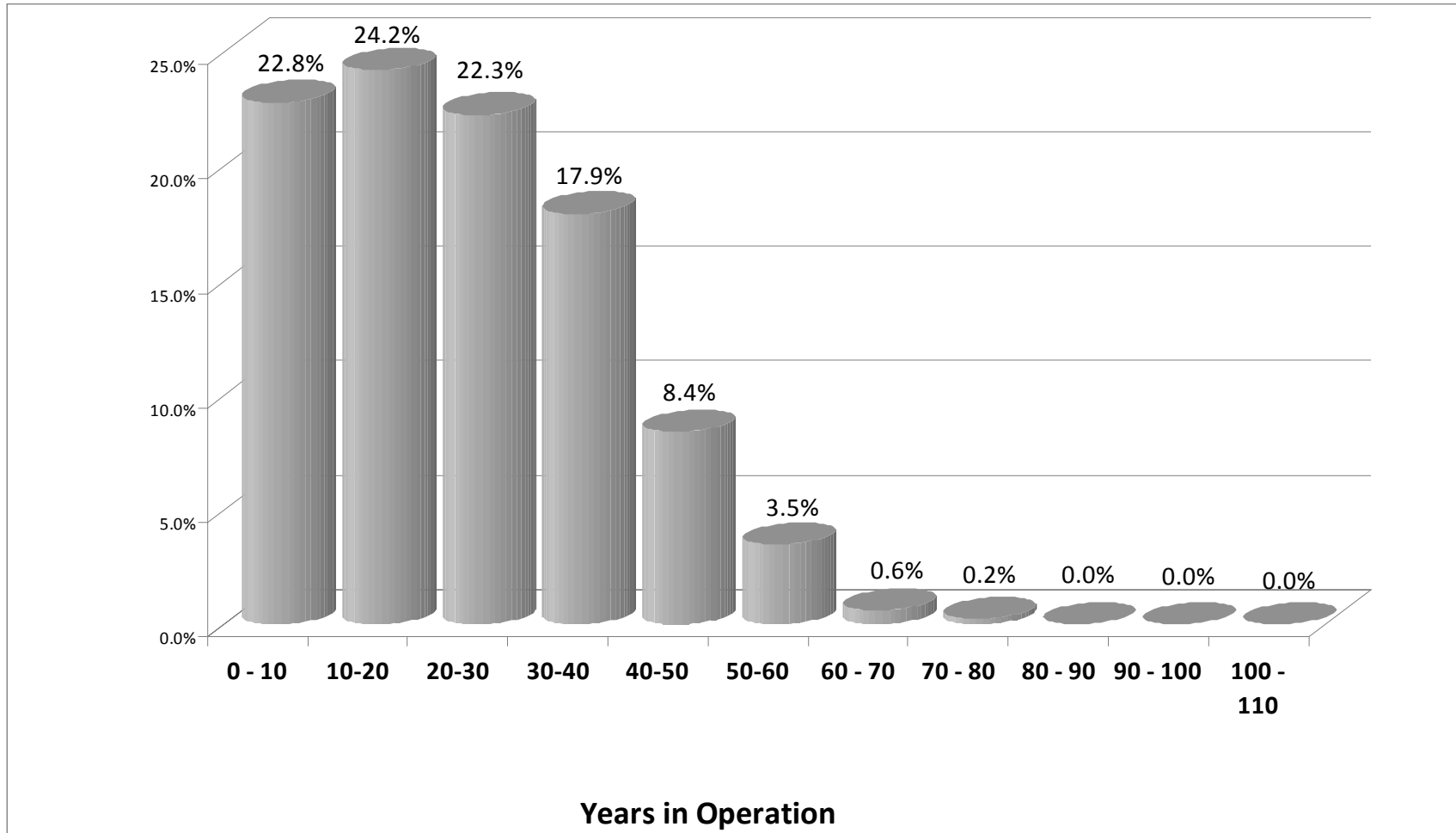
What parameters influence DGA levels ?

- Age ?
- Size ?
- Voltage Class ?
- Sealed / open ?
- Energized TC VS Non-Energized TC ?
- GSU / Transmission / Distribution ?
- North / South (Weather) ?
- Utility / Industrial ?
- Laboratories used ?
-

What parameters influence DGA levels ?

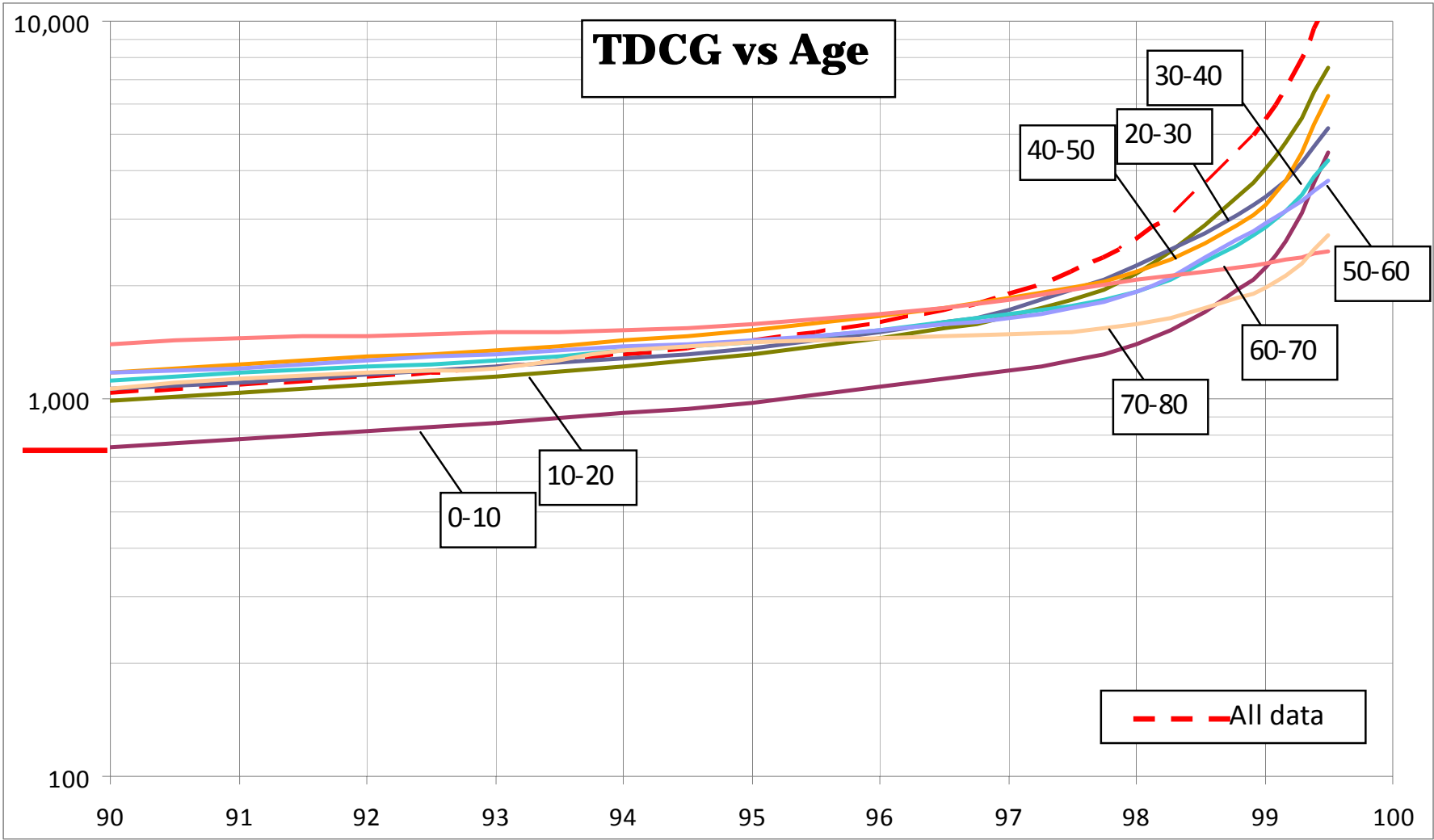
- Each individual parameter have to be studied to see if it has an influence
- Each influence has to be properly isolated
- Quantification of influence has to be statistically sound and documented

Example of a possible influential parameter: Age

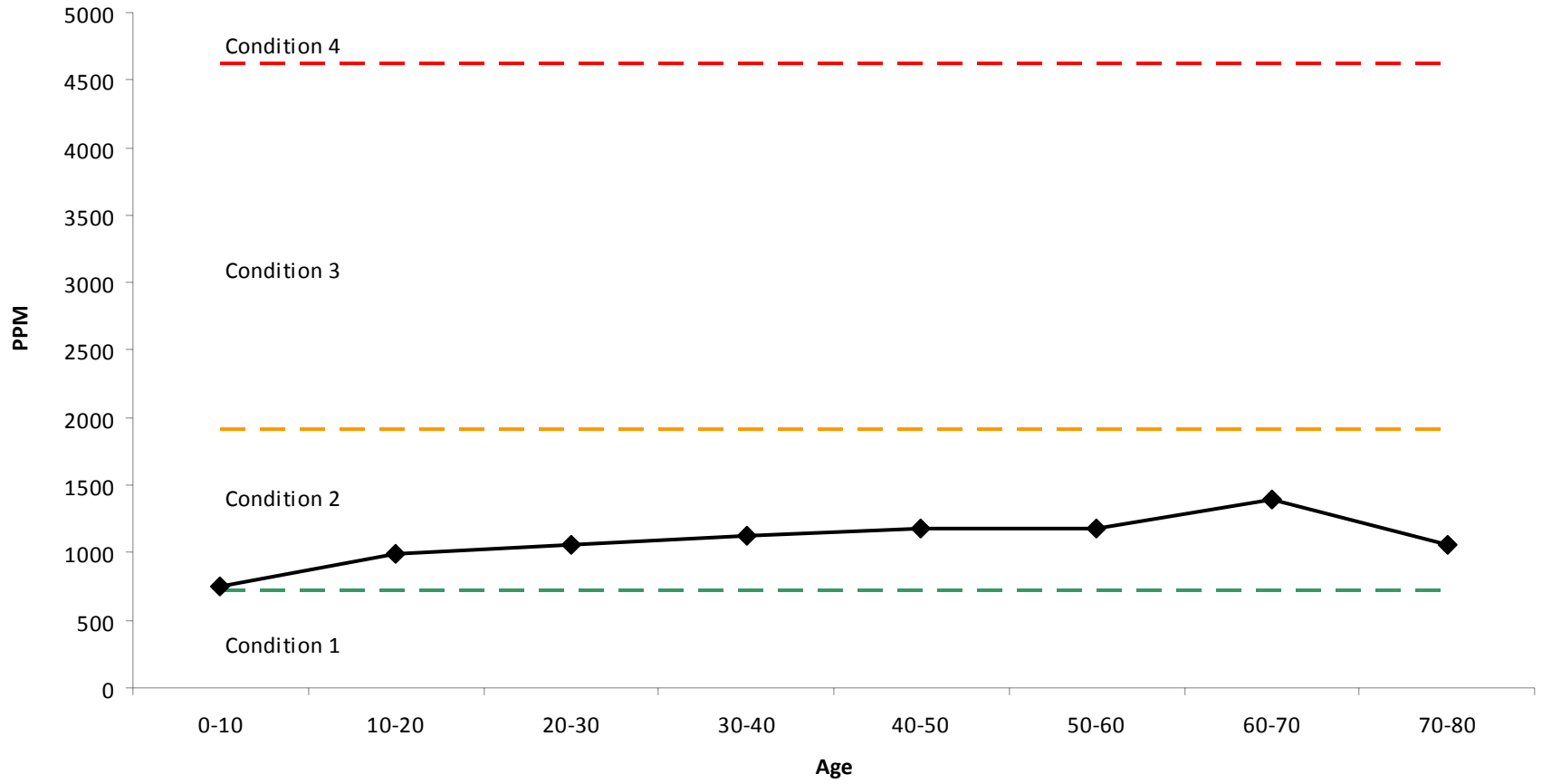


Example of a possible influential parameter: Age

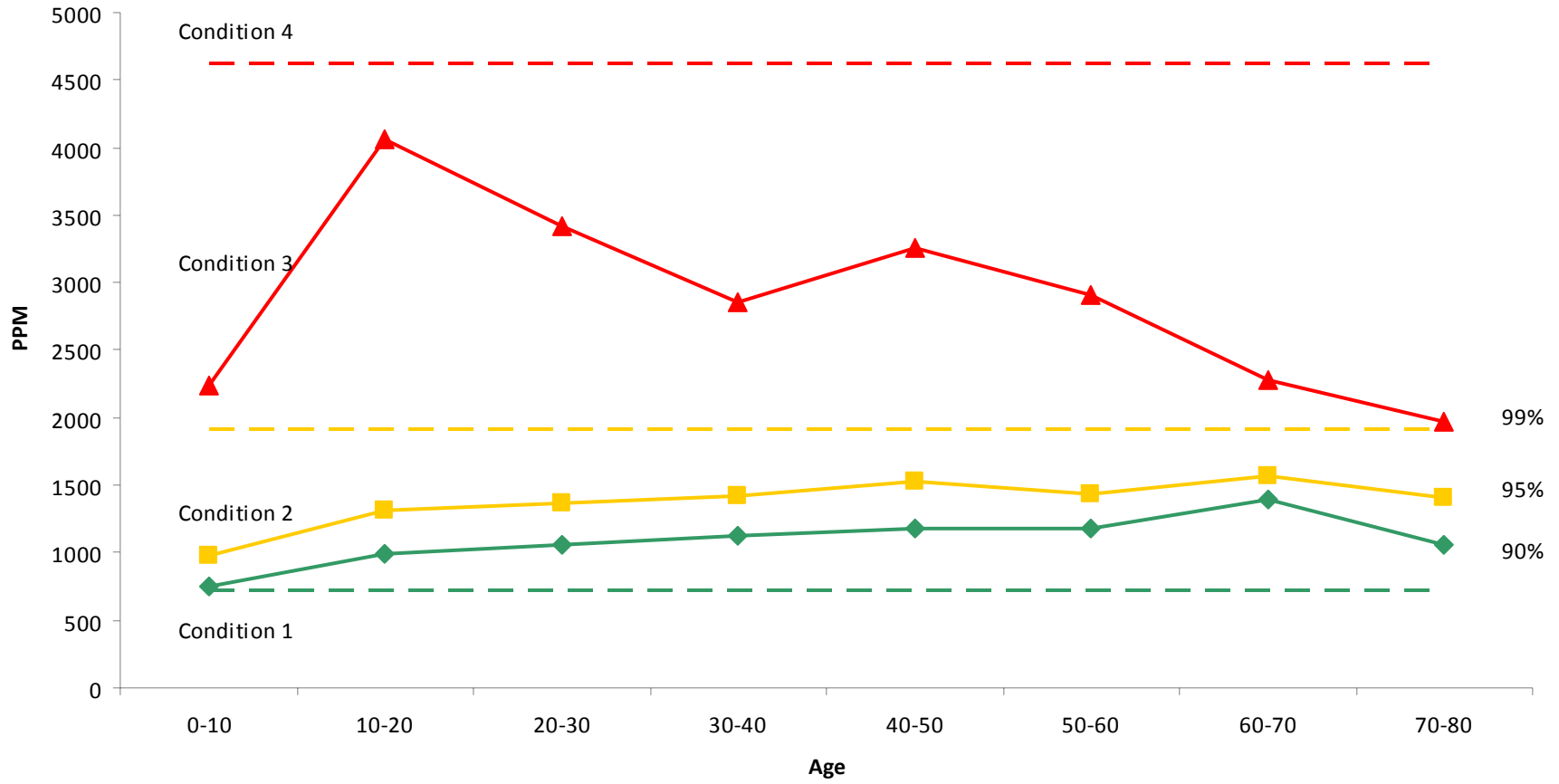
TDCG	all	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
90	1034	747.3	993	1061	1123	1179.3	1177	1391.1	1062.8
91	1087	783	1033.9	1107	1169	1233	1207.9	1438.7	1133.1
92	1148	820	1086	1154	1220	1292.6	1266.3	1458.2	1173.8
93	1222	865	1141.9	1212	1271	1350.6	1307.7	1495.1	1205
94	1311	920.8	1212	1276	1337	1430	1371.2	1528.4	1346
95	1429	980.6	1309.4	1367.6	1415	1525.6	1432	1569.8	1403.2
96	1602	1071	1445	1498	1521.8	1665.6	1512.5	1671.8	1447.4
97	1904	1193.4	1661	1724.5	1669.2	1856	1641.9	1834.8	1482
98	2656	1391.3	2147.9	2266.7	1924	2181.7	1925.2	2071.5	1568.3
99	5439	2239.7	4061.9	3418.3	2848.9	3261.9	2902.5	2282.2	1975.3
99.5	11386	4481.3	7501	5177.7	4295.7	6376.1	3803.1	2471.5	2723.8



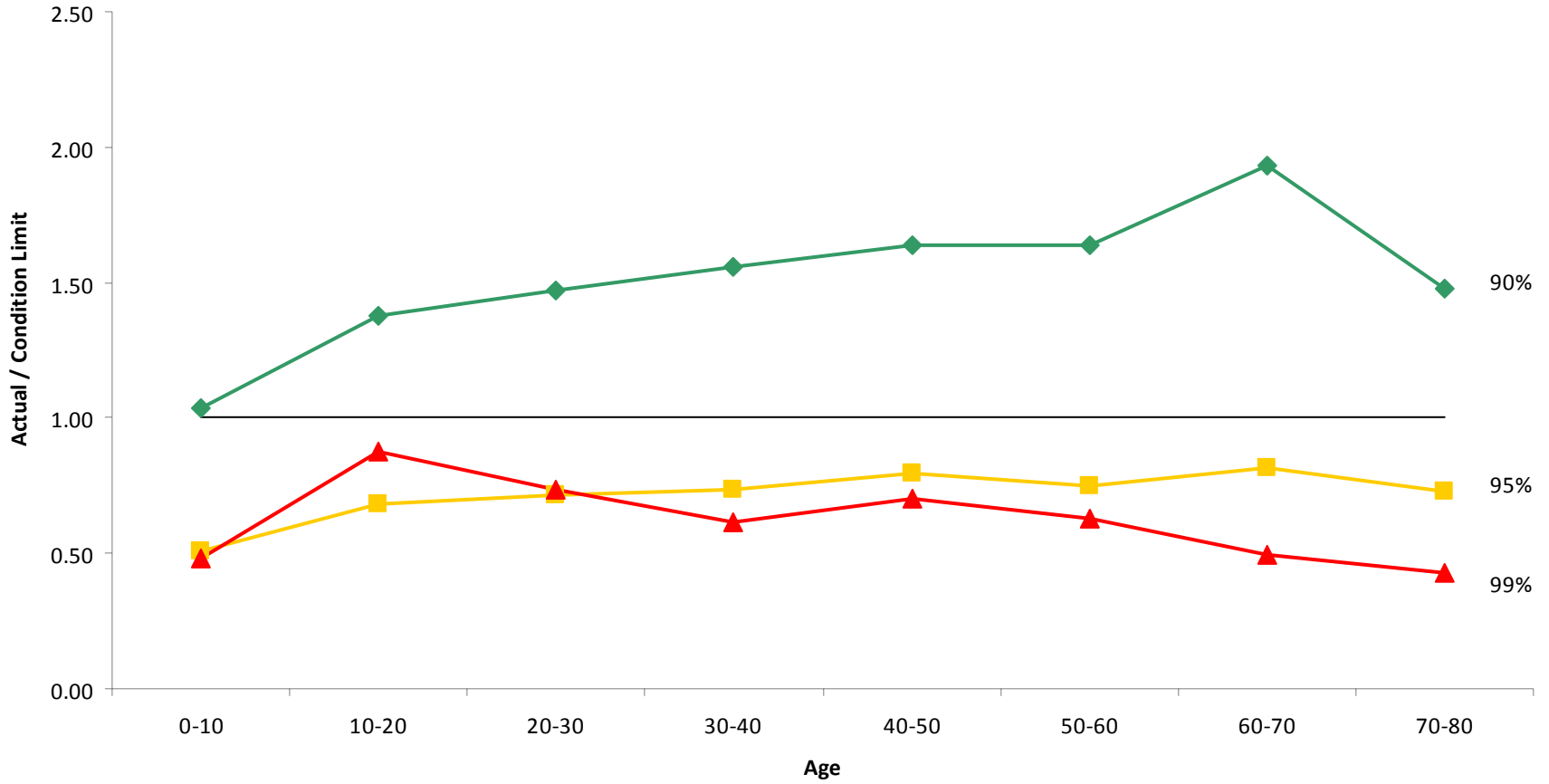
TDCG 90%



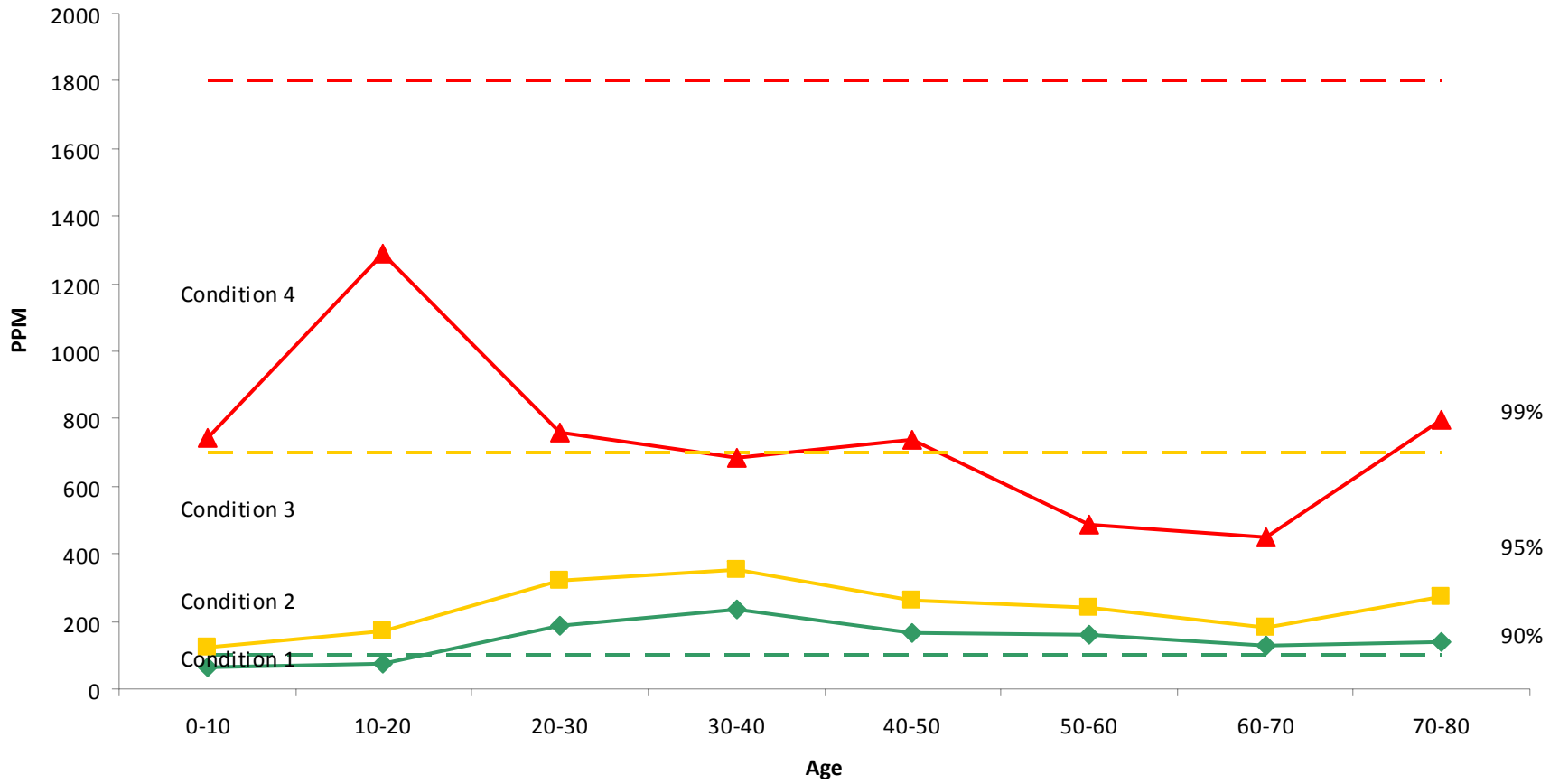
TDCG 90%, 95% and 99%



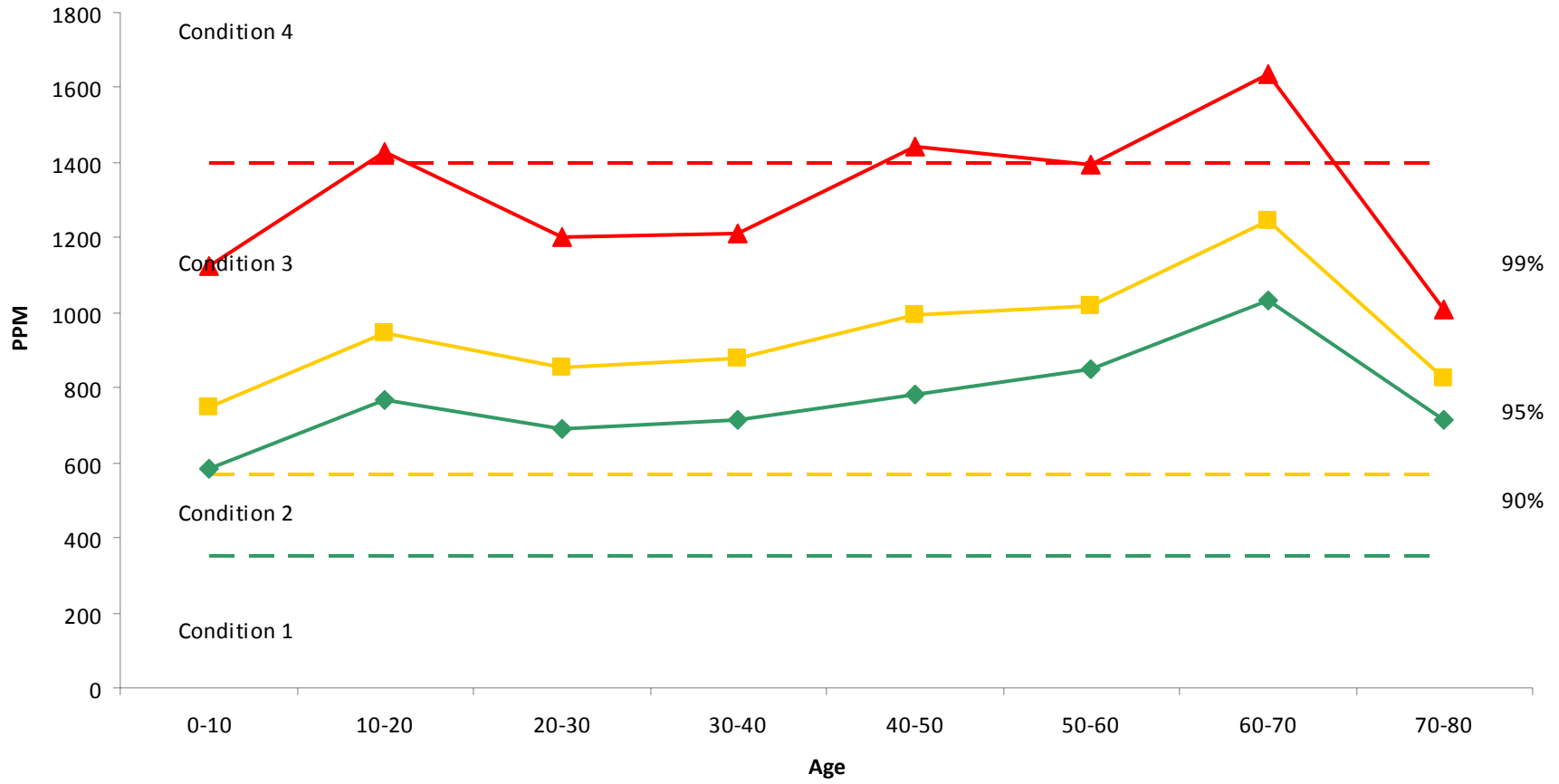
TDCG 90%, 95% and 99%



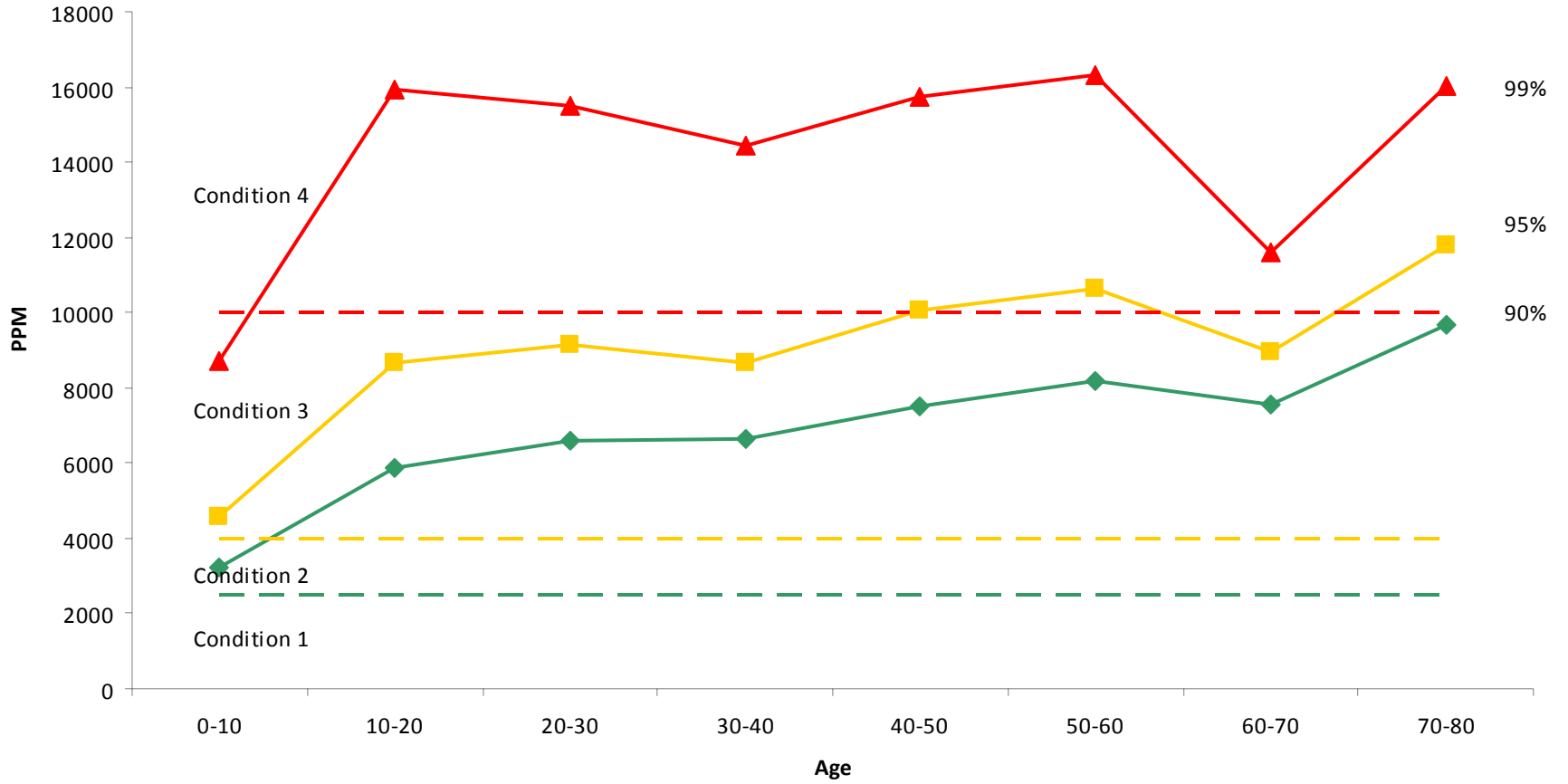
H2 90%, 95% and 99%



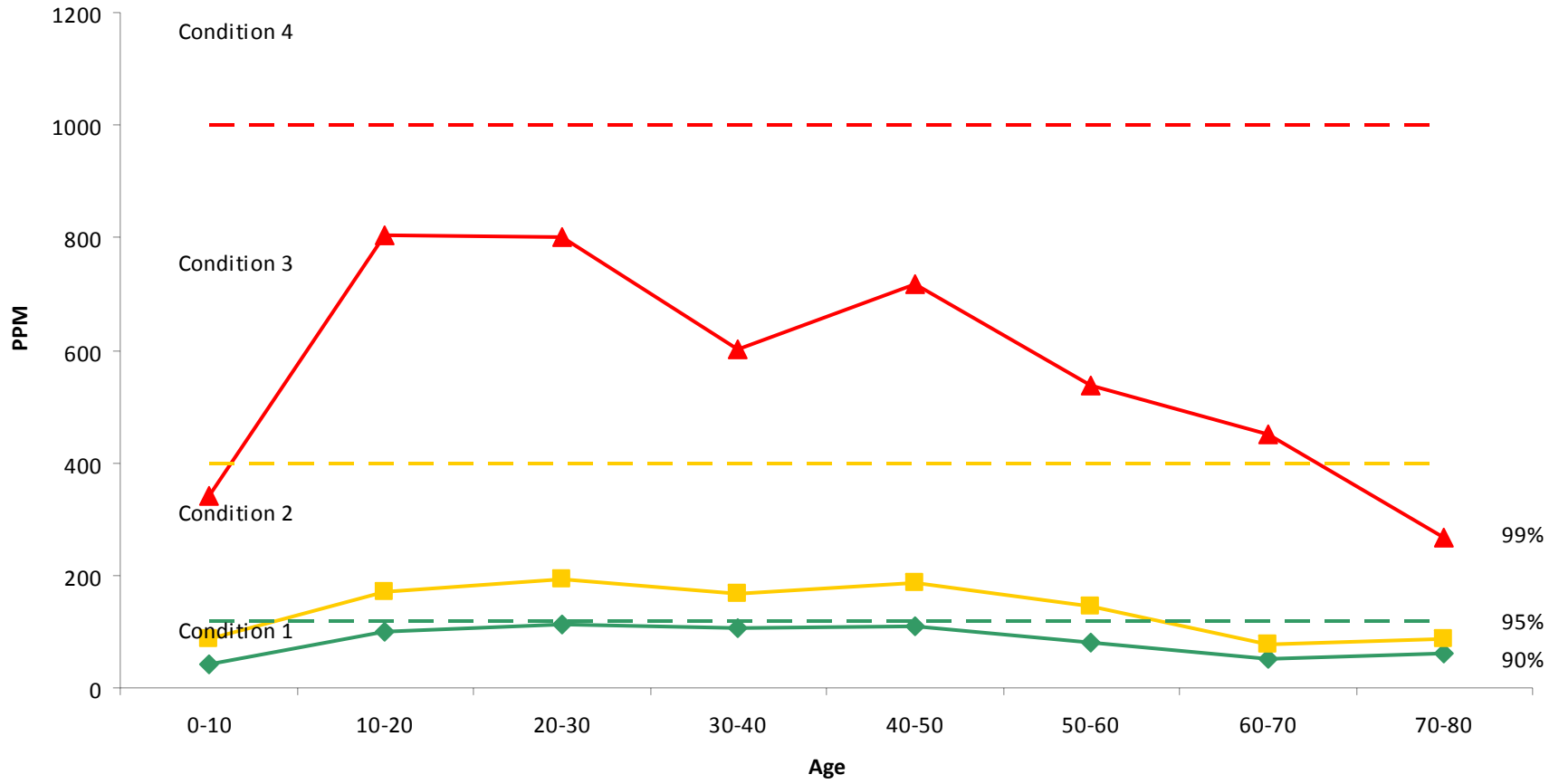
CO 90%, 95% and 99%



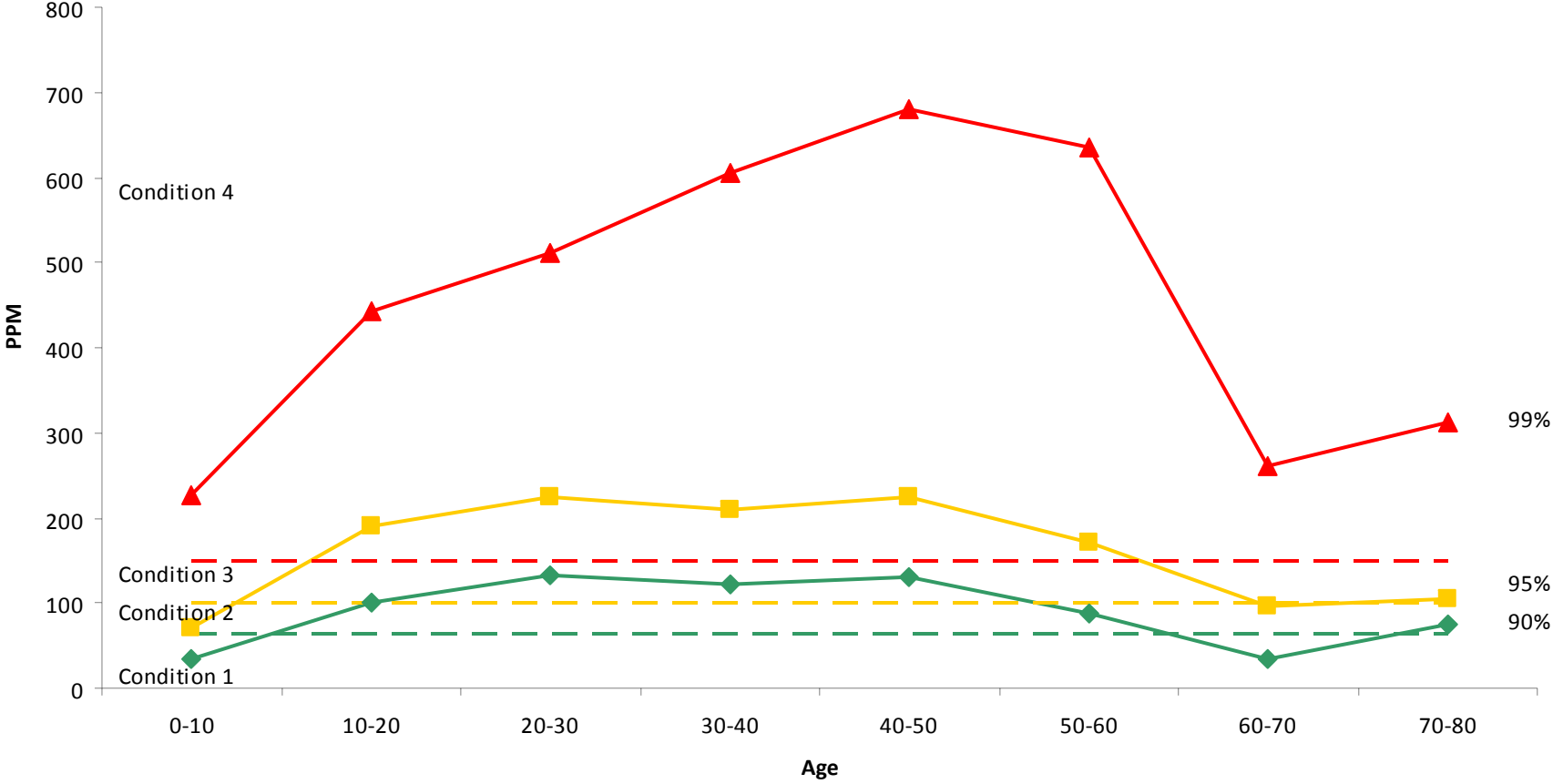
CO2 90%, 95% and 99%



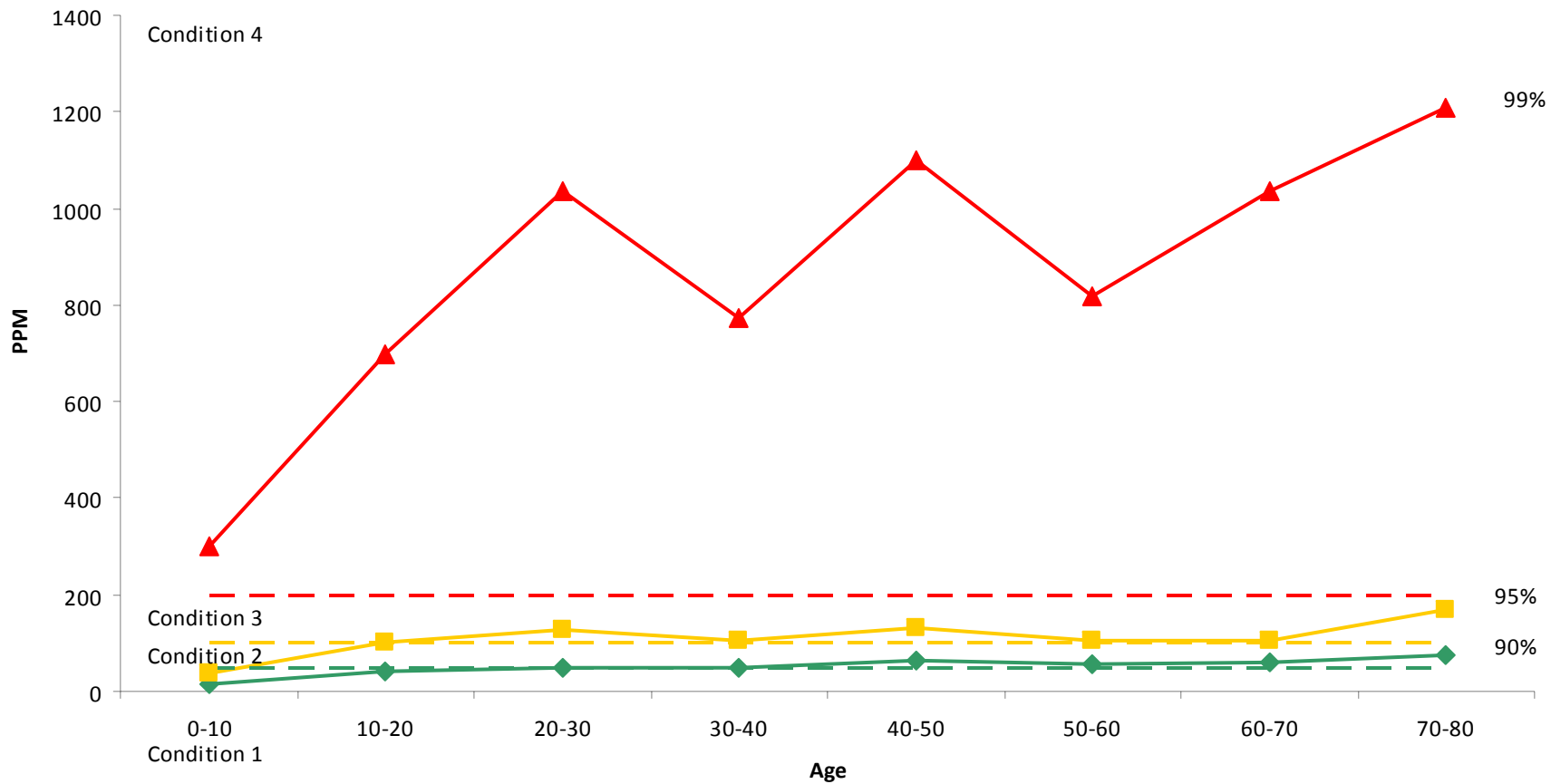
CH4 90%, 95% and 99%



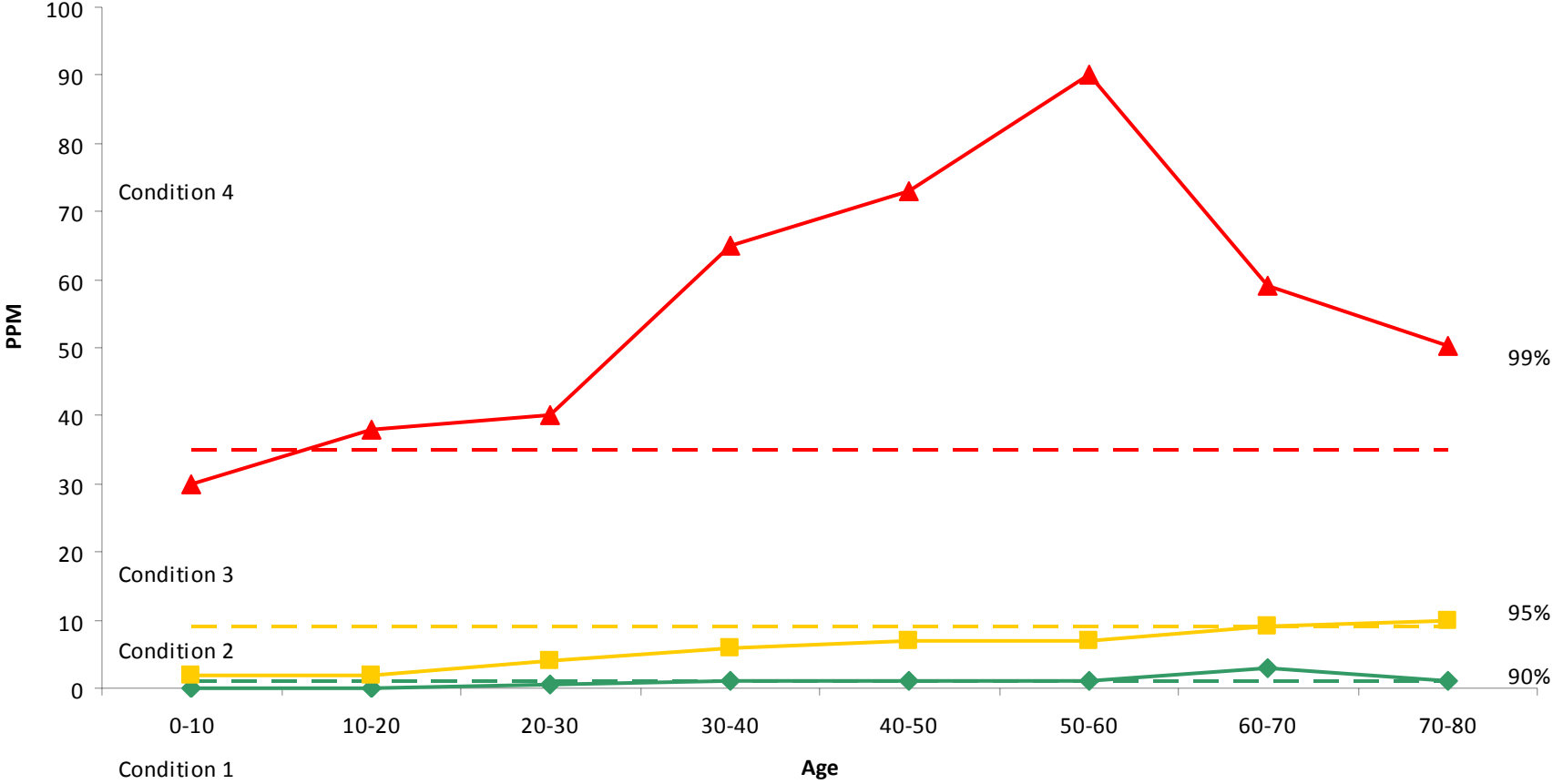
C2H6 90%, 95% and 99%



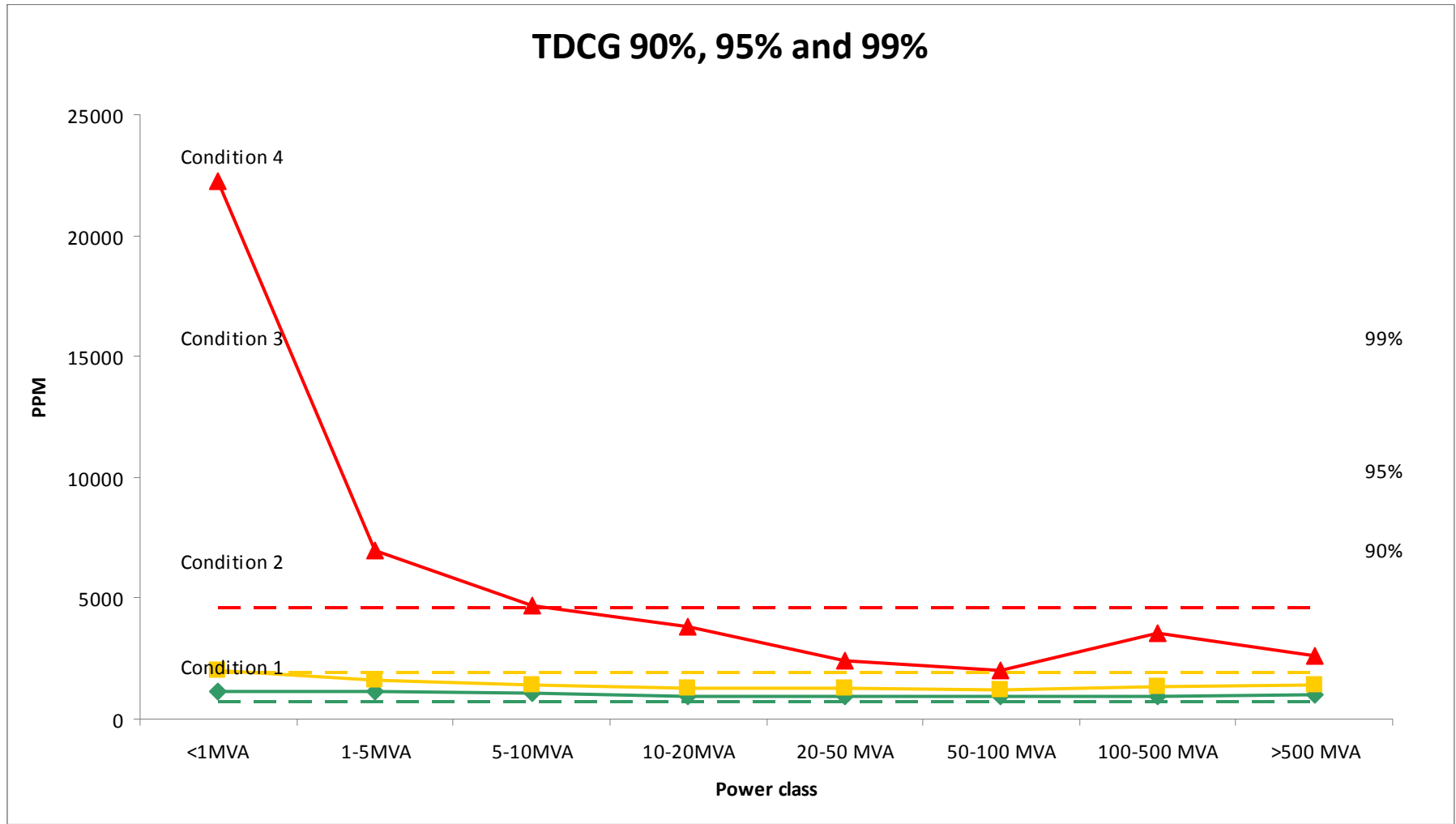
C2H4 90%, 95% and 99%



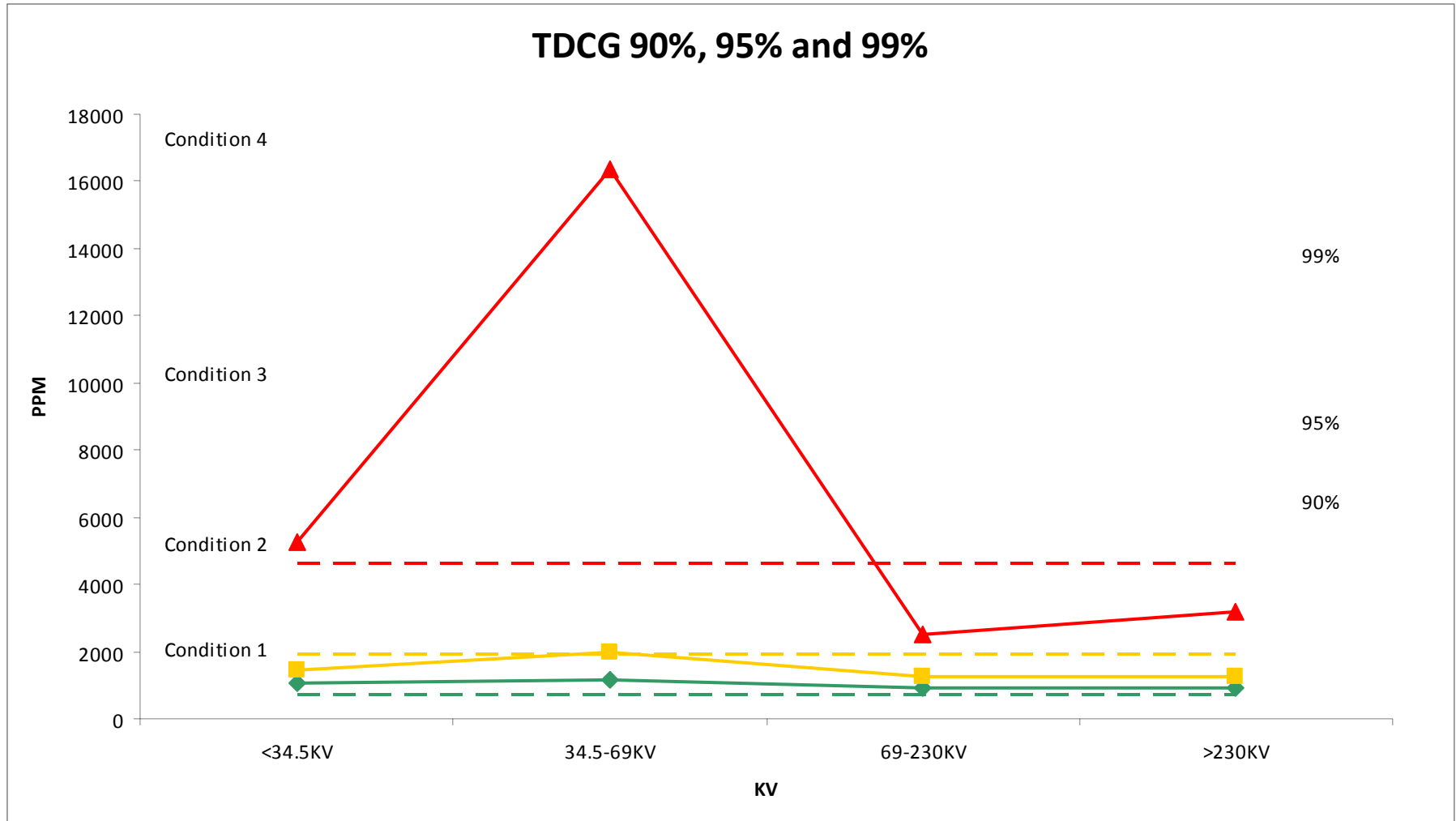
C2H2 90%, 95% and 99%



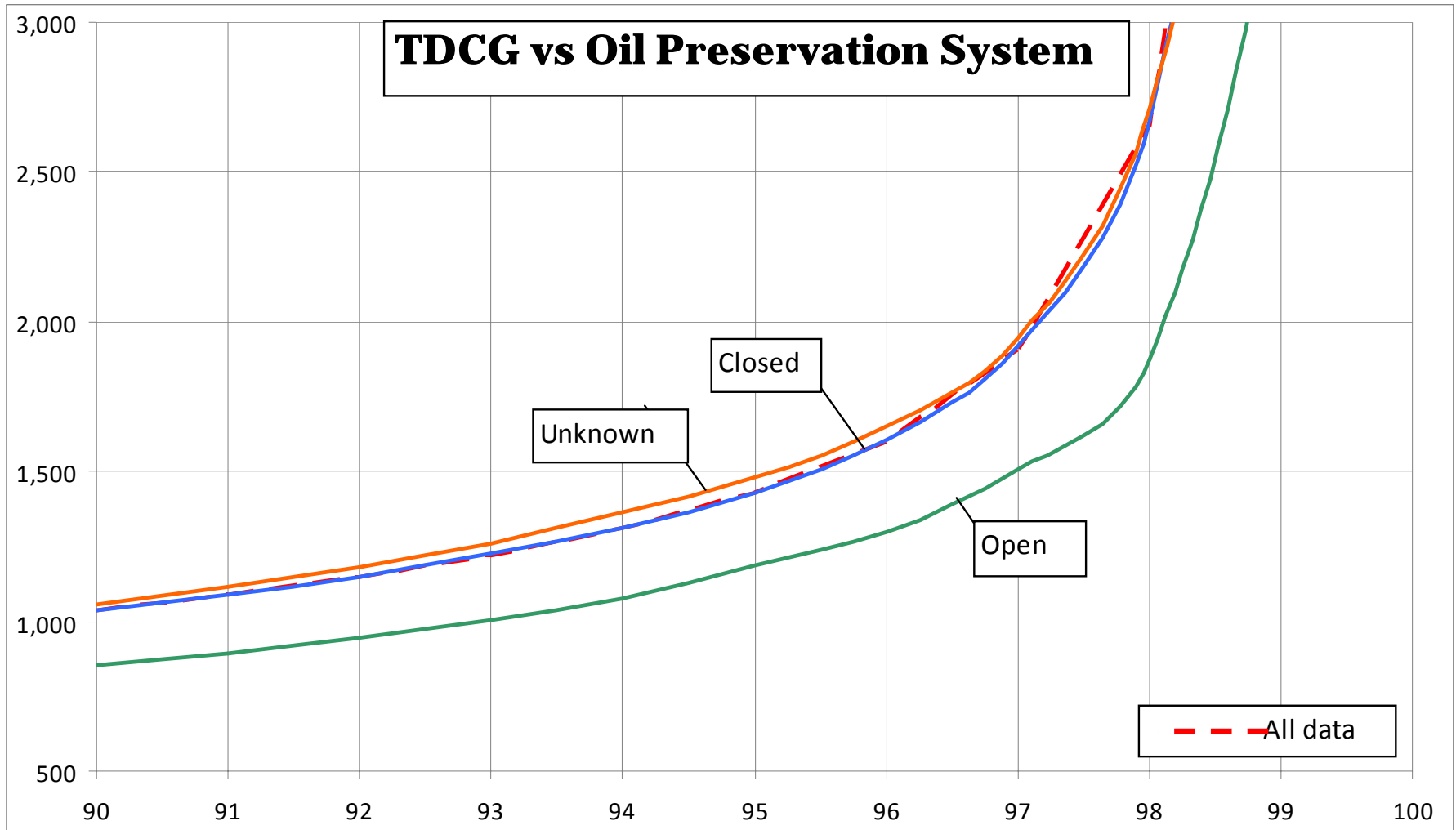
Influence of Rating



Influence of Voltage Class



Open or Closed



Suspicious VS All

90%	H2	CH4	C2H2	C2H4	C2H6	CO	CO2	TDCG
All	93	85	1	56	92	717	7491	1034
Suspicious	782	912	32	1255	452	738	7749	4305

Rate of rise ppm/day

ppm/day	H2	CH4	C2H2	C2H4	C2H6	CO	CO2	TDCG
90	0.13	0.08	0.00	0.04	0.08	0.60	6.6	1.01
95	0.43	0.23	0.00	0.14	0.23	1.25	14.1	2.5
99	6.9	3.3	0.22	3.1	2.0	6.3	69.6	26.3

Thank to all working on this
revision

Questions ?