

Proposed C13 MERIT SYSTEM

**Presented to C13 SP
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Norfolk, Va**

- **Parameters are those which were included in the motion the SP passed regarding readiness of the C13 test for PC-10**
 - The following pass/fail parameters included in system
 - + **Oil Consumption Delta**
 - + **Top Land Carbon**
 - + **Top Groove Carbon**
 - + **2nd Ring Top Carbon**
 - No Hot Stuck Rings needs to be a separate pass/fail due to on/off nature
 - Piston, Ring, or Liner distress to make test non-interpretable (validity criterion)

- **Current proposal differs from 10-10-05 proposal based on feedback CAT has received on original draft merit system**
- **Proposed limits determined by following criteria**
 - Merit System should provide clear separation of Oil A and Oil D/PC-10G as Failing and Passing oils
 - Anchor Limits: Set at levels that Caterpillar desires for acceptable oil performance based on analysis of matrix data
 - Cap Limits: Set at maximum level that Caterpillar is willing to accept for that individual parameter vs. previous system that set at the 3-test limits (Caps now at 1 to 2 sdev)
 - Max Merit Limits: Set at level consistent with best performance observed in the Matrix data for the parameter
- **Weightings set to emphasize the parameters that showed the most discrimination and are most critical to Caterpillar**

Proposed Merit System

- **Original proposal**

Parameter	Anchor	Cap	Max Merit	Weight
Delta OC	25	30.6	10	300
TLHC	11.5	13.2	3	300
TGC	48	51.5	30	250
UWD	130	135.3	95	150

- **Initial proposal with new parameters**

Parameter	Anchor	Cap	Max Merit	Weight
Delta OC	25	31	10	300
TLC	30	35	15	300
TGC	46	53	30	250
2RTC	17.5	25	5	150

- **2RTC parameter limits...**

- **Caterpillar's initial proposal for limits based on the following**
 - Heavy Carbon on 2RTC is not desirable
 - Cap: Set to exclude heavy carbon on a test with all six rings having 100% carbon (no varnish). Will allow some amount of heavy carbon on single/multiple rings if not 100% carbon ratings
 - Anchor: Set near max value seen in matrix for oil PC-10G (max of PC-10G was 17.25)
 - Max Merit: Set at level consistent with best performance observed in the Matrix data for the parameter (7.0)
 - 2RTC is smallest overall contributor (15%) to overall Merit.
- **Based on feedback received during various discussions with concerned parties, Caterpillar understands that there is concern over this parameter and a more conservative approach to limit setting may be needed to gain acceptance**

- **Concerns with 2RTC parameter**

- Matrix data not all generated with same methodology
 - + **Some labs did not rate heavy carbon**
 - + **Some labs rated chamfers and some did not**
 - + **Some labs rated “polished” carbon as light carbon since it did not have any depth**
- SP has agreed a final rating method and are in the process of comparing “matrix methods” to “final method” via a round robin ring rating
 - + **In general, expected that above items will lead to higher ratings with final method when heavy carbon is present**

- **Caterpillar want to ensure that limits**

- Exclude very poor oils (PC-10F, PC-10C)
- Based on statistics of current data (final method should improve consistency of results)

- **Caterpillar's revised proposal for limits based on the following**
 - Cap: Set to exclude poor oils (PC-10F & PC-10C) but allow other matrix oils to pass parameter
 - Anchor: Set at 2 sdev below the Cap (~10 lower)
 - Max Merit: Set at level consistent with best performance observed in the Matrix data for the parameter
- **Based on review of data, the following values were determined by Caterpillar**
 - Cap: 30
 - Anchor: 20
 - Max Merits: 5

Final Proposed Merit System

- **Following merit system currently planned for presentation to class panel for exit ballot...**

Parameter	Anchor	Cap	Max Merit	Weight
Delta OC	25	31	10	300
TLC	30	35	15	300
TGC	46	53	30	250
2RTC	20	30	5	150

Final Proposed Merit System

- **Following merit system currently planned for presentation to class panel for exit ballot...**

Parameter	Limit	Cap	Max Merit	Weight
Delta OC	25	31	10	300
TLC	30	35	15	300
TGC	46	53	30	300
2RTC	22	33	5	100

Final Proposed Merit System – Matrix Data

IND	Test Results (Outlier Screened)				Merit Calculation				Total	P / F
	OC	TLC	TGC	2RTC	OC	TLC	TGC	2RTC		
OILA	28.4	36.13	51.79	21.46	130.0	-67.5	51.8	103.2	217.5	Fail
OILA	26.6	31.25	54.54	22.29	220.0	225.0	-66.1	97.3	476.3	Fail
OILD	18.5	26.38	47.71	12.50	430.0	372.5	226.8	155.9	1185.2	Pass
OILD	13.3	23.75	44.17	11.88	534.0	425.0	334.4	159.6	1452.9	Pass
OILD	20.2	20.42	41.42	19.58	396.0	491.7	385.9	114.2	1387.8	Pass
PC10G	8.3	29.58	33.54	12.08	600.0	308.3	533.6	158.3	1600.3	Pass
PC10G	16	29.50	39.00	17.25	480.0	310.0	431.3	127.9	1349.2	Pass
PC10G	20.6	28.08	35.00	16.46	388.0	338.3	506.3	132.6	1365.2	Pass
PC10A	52	20.83	50.48	7.00	-1050.0	483.3	108.2	188.2	-270.3	Fail
PC10A	32.5	29.54	48.00	11.46	-75.0	309.2	214.3	162.0	610.5	Fail
PC10A	34.7	19.17	38.25	13.54	-185.0	516.7	445.3	149.8	926.7	Fail
PC10B	27.7	30.38	29.25	19.79	165.0	277.5	600.0	113.0	1155.5	Pass
PC10B	29.5	17.00	51.83	13.96	75.0	560.0	50.0	147.3	832.3	Fail
PC10B	32.8	27.38	44.71	17.92	-90.0	352.5	324.2	124.0	710.7	Fail
PC10B	33.4	38.00	52.96	19.38	-120.0	-180.0	1.8	115.4	-182.8	Fail
PC10B	35.2	24.17	49.13	21.04	-210.0	416.7	165.8	105.6	478.1	Fail
PC10B	54.4	27.96	42.08	12.71	-1170.0	340.8	373.4	154.7	-301.1	Fail
PC10B	28.4	20.21	45.71	19.17	130.0	495.8	305.5	116.7	1048.0	Pass
PC10C	19.2	26.83	56.65	33.96	416.0	363.3	-156.6	-8.7	614.0	Fail
PC10C	49.9	27.13	52.50	19.38	-945.0	357.5	21.4	115.4	-450.6	Fail
PC10D	35.6	23.21	40.00	8.13	-230.0	435.8	412.5	181.6	800.0	Fail
PC10D	8.8	26.08	32.96	16.04	600.0	378.3	544.5	135.0	1657.9	Pass
PC10D	6.7	21.46	44.58	11.67	600.0	470.8	326.6	160.8	1558.2	Pass
PC10E	59.1	28.63	47.54	14.38	-1405.0	327.5	233.9	144.9	-698.7	Fail
PC10E	16.8	24.21	42.75	9.38	464.0	415.8	360.9	174.3	1415.0	Pass
PC10E	9.8	17.38	33.75	30.21	600.0	552.5	529.7	25.4	1707.6	Pass
PC10E	26.8	35.63	41.96	12.50	210.0	-37.5	375.8	155.9	704.2	Fail
PC10E	17.3	16.88	41.75	19.17	454.0	562.5	379.7	116.7	1512.9	Pass
PC10E	25.4	24.70	57.83	24.79	280.0	406.0	-207.1	74.6	553.5	Fail
PC10F	29.9	35.63	41.33	37.71	55.0	-37.5	387.5	-42.8	362.2	Fail
PC10F	50.6	33.92	59.46	43.33	-980.0	65.0	-276.8	-93.9	-1285.7	Fail
PC10F	51.8	39.42	61.46	62.08	-1040.0	-265.0	-362.5	-264.4	-1931.9	Fail

Final Proposed Merit System – Matrix Data

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	OC	TLC	TGC	2RTC	OC	TLC	TGC	2RTC		
OILA	28.4	36.13	51.79	21.46	130.0	-67.5	43.2	154.8	260.4	Fail
OILA	26.6	31.25	54.54	22.29	220.0	225.0	-55.1	146.0	536.0	Fail
OILD	18.5	26.38	47.71	12.50	430.0	372.5	189.0	233.8	1225.3	Pass
OILD	13.3	23.75	44.17	11.88	534.0	425.0	278.6	239.3	1477.0	Pass
OILD	20.2	20.42	41.42	19.58	396.0	491.7	321.6	171.3	1380.6	Pass
PC10G	8.3	29.58	33.54	12.08	600.0	308.3	444.7	237.5	1590.5	Pass
PC10G	16	29.50	39.00	17.25	480.0	310.0	359.4	191.9	1341.3	Pass
PC10G	20.6	28.08	35.00	16.46	388.0	338.3	421.9	198.9	1347.1	Pass
PC10A	52	20.83	50.48	7.00	-1050.0	483.3	90.1	282.4	-194.2	Fail
PC10A	32.5	29.54	48.00	11.46	-75.0	309.2	178.6	243.0	655.8	Fail
PC10A	34.7	19.17	38.25	13.54	-185.0	516.7	371.1	224.6	927.4	Fail
PC10B	27.7	30.38	29.25	19.79	165.0	277.5	500.0	169.5	1112.0	Pass
PC10B	29.5	17.00	51.83	13.96	75.0	560.0	41.7	221.0	897.6	Fail
PC10B	32.8	27.38	44.71	17.92	-90.0	352.5	270.2	186.0	718.7	Fail
PC10B	33.4	38.00	52.96	19.38	-120.0	-180.0	1.5	173.2	-125.4	Fail
PC10B	35.2	24.17	49.13	21.04	-210.0	416.7	138.1	158.5	503.3	Fail
PC10B	54.4	27.96	42.08	12.71	-1170.0	340.8	311.2	232.0	-286.0	Fail
PC10B	28.4	20.21	45.71	19.17	130.0	495.8	254.6	175.0	1055.4	Pass
PC10C	19.2	26.83	56.65	33.96	416.0	363.3	-130.5	-13.1	635.7	Fail
PC10C	49.9	27.13	52.50	19.38	-945.0	357.5	17.9	173.2	-396.5	Fail
PC10D	35.6	23.21	40.00	8.13	-230.0	435.8	343.8	272.4	822.0	Fail
PC10D	8.8	26.08	32.96	16.04	600.0	378.3	453.8	202.6	1634.7	Pass
PC10D	6.7	21.46	44.58	11.67	600.0	470.8	272.1	241.2	1584.1	Pass
PC10E	59.1	28.63	47.54	14.38	-1405.0	327.5	194.9	217.3	-665.3	Fail
PC10E	16.8	24.21	42.75	9.38	464.0	415.8	300.8	261.4	1442.0	Pass
PC10E	9.8	17.38	33.75	30.21	600.0	552.5	441.4	38.1	1632.0	Pass
PC10E	26.8	35.63	41.96	12.50	210.0	-37.5	313.2	233.8	719.5	Fail
PC10E	17.3	16.88	41.75	19.17	454.0	562.5	316.4	175.0	1507.9	Pass
PC10E	25.4	24.70	57.83	24.79	280.0	406.0	-172.6	111.9	625.3	Fail
PC10F	29.9	35.63	41.33	37.71	55.0	-37.5	322.9	-64.2	276.2	Fail
PC10F	50.6	33.92	59.46	43.33	-980.0	65.0	-230.7	-140.9	-1286.6	Fail
PC10F	51.8	39.42	61.46	62.08	-1040.0	-265.0	-302.1	-396.6	-2003.7	Fail