

**PC-10 Matrix Funding & Design TF**  
**ASTM HDEOCP Meeting**  
**September 29, 2004**  
**Chicago, IL**

# PC-10 Engine Test Matrix

## *Funding Group*

- **ACC & API have agreed to match up to \$1MM EMA cash & in-kind contributions for PC-10 Precision & BOI matrix testing**
- **Three million dollars from trade associations will not fully fund the PC-10 matrix (C13, ISB, T-12)**
  - ❖ **Precision only = \$4.6MM total / 1.5MM funded (18 tests)**
  - ❖ **Precision + BOI = \$6.6MM total / 3.6MM funded (26 tests)**
- **Significant issues related to conditions and details of trade association contributions must be resolved**
  - ❖ **EMA cash & in-kind contributions must be established**
  - ❖ **Determine impact of ACC positions on minimum number of matrix runs per stand & maximum number of calibration tests**
  - ❖ **Funding meeting planned for week of October 11**

# PC-10 Engine Test Matrix

## *Areas of Progress*

- **Calibration criteria established by test development groups**
  - ❖ Two for first stand in a lab
  - ❖ One for additional stands
- **Recommendations for additive & base oil to be used in Precision-BOI matrices accepted**
  - ❖ Two additive technologies; EMA reviewing submissions
  - ❖ Three base oils spanning a wide range of saturates & viscosity index (Groups I, II, and III)
- **Generic matrix designs developed for many potential Precision-BOI and Precision only scenarios**

# PC-10 Engine Test Matrix

## Preliminary Precision / BOI Matrix Designs (9)

Matrices	15	16	17	18	16a	16b	16c	C-13	C-13
	1	2	3	4	5	6	7	8	9
No. of Stands	3	4	6	8	5	6	7	7	7
No. of Labs	2	2	5	6	3	4	5	5	5
No. of Oils	6	6	6	6	6	6	6	4	4
Total No. of Tests	20	20	20	20	20	20	20	26	26
No. of Tests/Oil	6,2	6,2	6,2	6,2	6,2	6,2	6,2	8,5	9,4
Detectable Difference in s of variable and using t Comparing reference oils only	2.89	2.91	2.98	3.09	2.94	2.98	3.02	1.97	2.08
	2.89	2.94	3.08	3.33	3.00	3.08	3.19	2.17	2.05
No. of Tests/Stand	7,6,7	5	4,3,4,3,3,3	4*2 4*3	4	4,3,4,3,3,3	3,3,3,3,3,2	4,3,4,3,4,4,4	4,3,4,3,4,4,4
Detectable Difference in s of variable and using t	1.97	2.25	2.78	3.45	2.55	2.78	3.38	2.64	2.64
Detectable Difference in s of variable taking the multiple comparison into account for several sample size combinations	2.30	2.89	4.08	5.75	3.50	4.08	5.26	3.77	3.77
	2.21		3.77	5.14		3.77	4.71	3.49	3.49
			4.36	6.30		4.36		4.03	4.03
No. of Tests/ Lab	13, 7	10, 10	7,4,3,3,3	4,4,3,3,3,3	8,8,4	7,7,3,3	6,6,3,3,2	7,7,4,4,4	7,7,4,4,4
Detectable Difference in s of variable and using t	1.66	1.59	2.52	2.89	2.20	2.52	3.02	2.17	2.17
Detectable Difference in s of variable taking the multiple comparison into account for several sample size combinations	1.66	1.59	3.50	4.41	2.60	3.28	4.27	2.88	2.88
			3.18	4.08	2.12	2.54	3.02	2.45	2.45
			3.87	4.71		3.88	3.70	3.24	3.24
Degrees of Freedom									
Oil	5	5	5	5	5	5	5	3	3
Stand(Lab)	1	2	1	2	2	2	2	2	2
Lab	1	1	4	5	2	3	4	4	4
Mean	1	1	1	1	1	1	1	1	1
Error	12	11	9	7	10	9	8	16	16
Total	20	20	20	20	20	20	20	26	26
95% CI for Sigma, Width^	0.93	0.99	1.14	1.37	1.06	1.14	1.24	0.78	0.78

# PC-10 Engine Test Matrix

## Preliminary Precision Matrix Designs (24)

Matrices	2	3	3*	6	7	7a	9	10	12	14	21	22	23	21a	22a	23a	3a	3b	3c	24	25	26	ISB	T-12
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
No. of Stands	3	4	4	4	4	5	5	5	6	6	5	6	7	5	6	7	5	6	7	7	7	7	6	7
No. of Labs	2	2	2	3	3	3	4	4	5	5	3	4	5	3	4	5	3	4	5	5	5	5	4	5
No. of Oils	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total No. of Tests	12	16	12	12	16	16	12	15	18	24	20	24	28	18	20	22	16	16	16	14	21	23	22	26
No. of Tests/Oil	6	8	6	6	8	8	6	7.8	9	12	10	12	14	9	10	11	8	8	8	7	10,11	12,11	11	13
Detectable Difference in s of variable and using t	2.14	1.78	2.18	2.18	1.78	1.80	2.24	1.89	1.68	1.41	1.56	1.41	1.29	1.67	1.57	1.49	1.80	1.82	1.85	2.08	1.53	1.45	1.48	1.35
No. of Tests/Stand	4	4	3	3	4	4,2,4,2,4	3,3,2,2,2	3	3	4	4	4	4	4,4,4,4,2	4,4,4,4,2,2	4,4,4,4,2,2,2	4,3,3,3,3	3,3,3,3,2,2	3,2,3,2,2,2,2	2	3	4,3,3,4,3,3,3	4,3,4,3,4,4	4,3,4,3,4,4,4
Detectable Difference in s of variable and using t	2.62	2.52	3.09	3.09	2.52	3.12	3.55	2.98	2.91	2.43	2.47	2.43	2.41	3.06	3.04	3.02	2.75	3.33	3.38	3.89	2.87	2.65	2.65	2.62
Detectable Difference in s of variable taking the multiple comparison into account for several sample size combinations	3.12	3.23	4.12	4.12	3.23	4.29	5.26	4.14	4.16	3.35	3.30	3.35	3.40	4.14	4.27	4.37	3.78	4.87	5.26	6.47	4.17	3.81	3.68	3.71
						3.50	4.70							3.38	3.49	3.57	4.04	4.36	4.71			3.53	3.41	3.44
						4.95	5.76								4.93	5.04		5.34	5.77			4.07	3.94	3.97
No. of Tests/Lab	8,4	8,8	6,6	6,3,3	8,4,4	6,6,4	6,2,2,2	6,3,3,3	6,3,3,3,3	8,4,4,4,4	8,8,4	8,8,4,4	8,8,4,4,4	8,8,2	8,8,2,2	8,8,2,2,2	7,6,3	6,6,2,2	5,5,2,2,2	4,4,2,2,2	6,6,3,3,3	7,7,3,3,3	7,7,4,4	7,7,4,4,4
Detectable Difference in s of variable and using t	2.27	1.78	2.18	2.67	2.18	2.32	3.17	2.58	2.52	2.11	2.14	2.11	2.09	2.79	2.78	2.76	2.48	2.98	3.10	3.37	2.87	2.40	2.18	2.15
Detectable Difference in s of variable taking the multiple comparison into account for several sample size combinations	2.27	1.78	2.18	3.21	2.56	2.74	4.33	3.88	3.44	2.79	2.49	2.64	2.74	3.27	3.52	3.69	2.93	3.88	4.38	4.99	3.86	3.19	2.74	2.84
				3.71	2.96	2.45	5.30	3.88	3.97	3.22	2.03	2.16	3.17	2.30	2.23	2.34	3.00	2.74	3.31	4.07		3.78	2.34	2.42
												3.05	2.03		4.46	4.67	2.36	4.75	5.23	5.76			3.09	3.20
Degrees of Freedom																								
Oil	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Stand(Lab)	1	2	2	1	1	2	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Lab	1	1	1	2	2	2	3	3	4	4	2	3	4	2	3	4	2	3	4	4	4	4	3	4
Mean	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Error	8	11	7	7	11	10	6	9	11	17	14	17	20	12	13	14	10	9	8	6	13	15	15	18
Total	12	16	12	12	16	16	12	15	18	24	20	24	28	18	20	22	16	16	16	14	21	23	22	26
95% CI for Sigma, Width^	1.24	0.99	1.37	1.37	0.99	1.06	1.56	1.14	0.99	0.75	0.84	0.75	0.68	0.93	0.89	0.84	1.06	1.14	1.24	1.56	0.89	0.81	0.81	0.72

# PC-10 Engine Test Matrix

## *Next Steps*

- **Agree on plan to fund matrix testing; finalize MOA for each new test type**
- **Decision on Precision-BOI versus Precision only for each test; agree on BOI if appropriate**
- **Determine the number of labs and stands participating in the new test matrices**
- **Identify suitable Precision-BOI or Precision only designs for each new test**
- **Final selection & blending of matrix oils**