Ohio DOT 2017 PG Binder Round Robin Results

PG 58-28	ODOT A	ODOT B	LAB #1	LAB #2	LAB #3	LAB #4	LAB #5	LAB #6	LAB #7	LAB #8A	LAB #8B	LAB #9	LAB #10A	LAB #10B	LAB #10C	LAB #11	LAB #12	LAB #13
ROTATIONAL VISCOSITY	0.288	0.391	0.277	0.268	0.270	0.302	0.278	0.293	0.285							0.250	0.313	0.280
PENETRATION	134	136	133	136	133	136	135	127	136							123	141	135
COMPLEX MODULUS	1.17	1.17	1.21	1.16	1.25	1.20	1.19	1.38	1.19	1.18		1.26	1.25			1.19	1.22	1.20
PHASE ANGLE	86.6	86.6	87.0	86.9	86.8	87.0	87.0	86.4	87.0	87.0		87.1	86.6			86.9	86.6	87.0
ORIGINAL DSR	1.17	1.17	1.22	1.16	1.25	1.20	1.20	1.39	1.19	1.18		1.26	1.26			1.19	1.22	1.20
COMPLEX MODULUS	3.40	3.29	3.50	3.25	3.63		3.23	3.50	3.65							3.22	3.51	3.34
PHASE ANGLE	82.4	82.5	82.3	82.5	82.1		82.6	82.4	82.0							82.4	82.1	82.5
RTFO DSR	3.43	3.32	3.53	3.28	3.66		3.26	3.53	3.68							3.24	3.54	3.37
MASS CHANGE %	-0.394	-0.382	-0.334	-0.320	-0.328		-0.341	-0.333	-0.361							-0.287	-0.376	-0.336
PAV WITH VDO																		
PHASE ANGLE	43.7	43.7	43.9	44.1	44.8		44.8	43.4	43.8							42.3	44.1	
PAV DSR	3290	3470	3970	3431	3348		3830	3705	3910							4237	3810	
ESTIMATED STIFF 1	180	183	181	174	177		177	162	176							161	172	
ESTIMATED STIFF 2	186	173	176	181	172		172	183	166							158	180	
AVERAGE EST STIFF	183.0	178.0	178.5	177.5	174.5		174.5	172.5	171.0							159.5	176.0	
RANGE	-6	10	5	-7	5		5	-21	10							3	-8	
M-VALUE 1	0.324	0.317	0.315	0.322	0.318		0.330	0.298	0.317							0.327	0.319	
M-VALUE 2	0.323	0.314	0.316	0.318	0.323		0.327	0.308	0.322							0.327	0.317	
AVERAGE M-VALUE	0.324	0.316	0.316	0.320	0.321		0.329	0.303	0.320								0.318	
RANGE	0.001	0.003	-0.001	0.004	-0.005		0.003	-0.010	-0.005							0.000	0.002	
PG 76-22M																		
ROTATIONAL VISCOSITY	1.388	1.413	1.315	1.298	1.350	1.360	1.317	1.381	1.356							1.163	1.432	1.377
COMPLEX MODULUS	1.27	1.30	1.30	1.29	1.39	1.30	1.29	1.41	1.31	1.30		1.43	1.28			1.27	1.34	1.30
PHASE ANGLE	73.1	73.1	73.5	73.4	73.2	73.0	73.5	73.0	73.4	73.5		73.4	73.5			73.4	72.8	73.6
ORIGINAL DSR	1.33	1.36	1.36	1.35	1.45	1.36	1.34	1.47	1.36	1.36		1.49	1.33			1.33	1.40	1.36
COMPLEX MODULUS	3.27	3.38	3.00	3.11	3.39		2.94	3.56	3.39							3.38	3.28	3.03
PHASE ANGLE	66.1	65.7	66.8	66.2	65.8		66.9	65.4	65.7							65.9	66.3	66.7
RTFO DSR	3.58	3.71	3.26	3.40	3.72		3.20	3.91	3.72							3.70	3.58	3.30
ELASTIC RECOVERY	75.5	75.5	77.0	75.0	75.0		73.8	79.0	75.5							81.0		76.0
PAV WITH VDO																		
PHASE ANGLE	47.8	46.7	48.0	47.4	49.5		49.2	46.1	49.2							46.2	48.3	
PAV DSR	2140	2350	2080	1995	1707		1980	1465	1750							2281	1990	
ESTIMATED STIFF 1	167	172	174	162	156		158	169	155							152	183	
ESTIMATED STIFF 2	178	185	160	162	158		162	153	158							151	173	
AVERAGE EST STIFF	172.5	178.5	167.0	162.0	157.0		160.0	161.0	156.5							151.5	178.0	
RANGE	-11	-13	14	0	-2		-4	16	-3							1	10	
M-VALUE 1	0.320	0.312	0.314	0.314	0.324		0.321	0.332	0.321							0.330	0.306	
M-VALUE 2	0.319	0.314	0.313	0.312	0.324		0.319	0.327	0.324							0.331	0.308	
AVERAGE M-VALUE	0.320	0.313	0.314	0.313	0.324		0.320	0.330	0.323							0.331	0.307	
RANGE	0.001	-0.002	0.001	0.002	0.000		0.002	0.005	-0.003							-0.001	-0.002	
MSCR at 64 °C on Original																		
Avg % Recovery @ 3.2 kPa	32.14	32.56	31.79	32.50	32.90		31.21	34.40	32.47							34.53	33.55	32.82
Jnr @ 3.2 kPa	1.18	1.13	1.14	1.15	1.04		1.11	0.97	1.09							0.99	1.03	1.10
% Diff. between Jnr	51.95	50.39	50.79	42.17	57.40		44.41	48.38	36.82							47.03	47.42	37.34
MSCR at 64 °C on RTFO																		
Avg % Recovery @ 3.2 kPa	65.05	66.49	62.62	63.35	66.70		61.58	66.83	64.65							66.40	64.01	62.37
Jnr @ 3.2 kPa	0.18	0.17	0.21	0.21	0.17		0.23	0.17	0.17							0.17	0.19	0.21
% Diff. between Jnr	28.02	27.67	28.78	11.36	42.40		30.39	30.55	8.60							28.24	28.63	10.15
DSR ELASTIC RECOVERY	55.70	55.00																
Between 1 & 2 Std. Dev					x			x								x		
Greater than 2 Std Dev																		

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PG 58-28	LAB #14	LAB #15	LAB #16	LAB #17	LAB #18A	LAB #18B	LAB #19	LAB #20	LAB #21	LAB #22	LAB #23	LAB #24	LAB #25	LAB #26	LAB #27	LAB #28	LAB #29	LAB #30
ROTATIONAL VISCOSITY	0.285	0.276		0.240	1.043	1.041	0.265	0.283	0.280	0.274	0.238	0.294	0.273	0.338	0.275	0.283	0.268	0.280
PENETRATION	129	136		137			124	135	137	127	136	137	120	143	145	134	138	142
COMPLEX MODULUS	1.22	1.19	1.23	1.19	1.19	1.18	1.17	1.20	1.18	1.16	1.16	1.17	1.21	1.27	1.20	1.24	1.19	1.12
PHASE ANGLE	86.9	87.0	86.9	86.7	87.1	87.0	87.0	86.9	86.9	87.0	87.0	86.9	86.8	86.9	86.9	86.9	86.9	87.0
ORIGINAL DSR	1.23	1.19	1.23	1.19	1.19	1.19	1.17	1.20	1.18	1.16	1.16	1.18	1.21	1.27	1.20	1.24	1.19	1.12
COMPLEX MODULUS	3.25	3.37		3.30			3.21	2.97	3.19	3.40	3.37	3.34	3.28	3.31	3.59	3.29	3.64	3.36
PHASE ANGLE	82.1	82.4		82.6			82.6	83.2	82.7	82.4	82.5	82.3	82.4	82.7	82.3	82.6	82.0	82.3
RTFO DSR	3.27	3.40		3.33			3.24	3.62	3.20	3.43	3.40	3.37	3.31	3.33	3.62	3.32	3.68	3.39
MASS CHANGE %	-0.270	-0.394		-0.354			-0.387	-0.335	-0.397	-0.326	-0.322	-0.351	-0.366	-0.169	-0.399	-0.251	-0.467	-0.386
PAV WITH VDO																		
PHASE ANGLE	43.9	43.5		44.3			43.8	43.9	44.3	44.4	44.7	44.7	43.4	45.1	43.1	44.4	43.9	43.4
PAV DSR	3180	3850		3780			2340	3080	3750	3668	3726	3680	4098	3780	4311	3519	3849	3640
ESTIMATED STIFF 1	178	194		170			171	160	173	165	180	171	197	166	190	172	184	179
ESTIMATED STIFF 2	178	195		171			175	163	176	174	180	178	202	163	193	160	183	163
AVERAGE EST STIFF	178.0	194.5		170.5			173.0	161.5	174.5	169.5	180.0	174.5	199.5	164.5	191.5	166.0	183.5	171.0
RANGE	0	-1	0	-1			-4	-3	-3	-9	0	-7	-5	3	-3	12	1	16
M-VALUE 1	0.307	0.313		0.328			0.313	0.310	0.328	0.324	0.320	0.321	0.304	0.313	0.314	0.312	0.325	0.315
M-VALUE 2	0.309	0.310		0.329			0.319	0.320	0.330	0.322	0.320	0.323	0.303	0.318	0.319	0.313	0.322	0.325
AVERAGE M-VALUE	0.308	0.312		0.329			0.316	0.315	0.329	0.323	0.320	0.322	0.304	0.316	0.317	0.313	0.324	0.320
RANGE	-0.002	0.003	0.000	-0.001			-0.006	-0.010	-0.002	0.002	0.000	-0.002	0.001	-0.005	-0.005	-0.001	0.003	-0.010
PG 76-22M																		
ROTATIONAL VISCOSITY	1.425	1.375		1.385	1.103	1.066	1.248	1.391	1.337	1.332	1.313	1.375	1.265	1.450	1.320	1.311	1.303	1.405
COMPLEX MODULUS	1.31	1.33	1.31	1.31	1.42	1.33	1.28	1.28	1.25	1.24	2.28	1.29	1.27	1.34	1.30	1.39	1.31	1.23
PHASE ANGLE	73.4	73.5	73.3	73.1	73.0	73.4	73.5	73.3	73.5	73.6	71.2	73.4	73.4	73.1	73.2	72.9	73.1	73.3
ORIGINAL DSR	1.37	1.39	1.37	1.36	1.42	1.39	1.33	1.34	1.31	1.29	2.41	1.35	1.33	1.40	1.36	1.46	1.37	1.29
COMPLEX MODULUS	3.26	3.22		3.05			3.02	3.08	3.12	3.05	5.49	2.77	2.72	3.21	3.17	3.21	3.16	2.95
PHASE ANGLE	66.1	66.0		66.8			66.6	66.4	65.9	66.5	64.7	67.4	66.5	66.4	66.2	66.3	66.0	66.2
RTFO DSR	3.57	3.53		3.29			3.29	3.36	3.42	3.33	6.07	3.00	2.97	3.50	3.46	3.50	3.46	3.22
ELASTIC RECOVERY	76.2	75.0		74.5					75.0	72.8	75.5	77.5	75.5	75.2	75.0	75.0	77.5	75.0
PAV WITH VDO																		
PHASE ANGLE	47.0	43.4		48.9			48.7	48.3	48.5	49.1	48.2	50.3	46.3	48.6	47.6	47.1	48.6	49.0
PAV DSR	2110	4370		1980			2050	1915	1975	1786	2107	1610	2318	2040	2230	2351	1904	1790
ESTIMATED STIFF 1	150	181		159			157	158	173	154	171	154	157	161	188	163	171	161
ESTIMATED STIFF 2	154	184		161			162	159	173	160	173	161	164	145	190	170	164	163
AVERAGE EST STIFF	152.0	182.5		160.0			159.5	158.5	173.0	157.0	172.0	157.5	160.5	153.0	189.0	166.5	167.5	162.0
RANGE	-4	-3	0	-2			-5	-1	0	-6	-2	-7	-7	16	-2	-7	7	-2
M-VALUE 1	0.314	0.312		0.322			0.313	0.319	0.311	0.331	0.315	0.335	0.310	0.314	0.309	0.314	0.324	0.329
M-VALUE 2	0.315	0.310		0.321			0.312	0.316	0.313	0.328	0.316	0.331	0.308	0.314	0.312	0.310	0.327	0.325
AVERAGE M-VALUE	0.315	0.311		0.322			0.313	0.318	0.312	0.330	0.316	0.333	0.309	0.314	0.311	0.312	0.326	0.327
RANGE	-0.001	0.002	0.000	0.001			0.001	0.003	-0.002	0.003	-0.001	0.004	0.002	0.000	-0.003	0.004	-0.003	0.004
MSCR at 64 °C on Original																		
Avg % Recovery @ 3.2 kPa	31.33	32.56		32.27			30.87	31.67	31.88	32.15	32.35	31.95	46.43	32.40	32.70	34.51	34.89	33.22
Jnr @ 3.2 kPa	1.14	1.07		1.12			1.20	1.13	1.12	1.16	1.14	1.12	0.68	1.08	1.12	1.00	1.04	1.12
% Diff. between Jnr	45.61	46.61		44.11			34.35	46.07	47.61	46.42	45.73	48.00	29.71	59.65	49.00	63.28	48.53	49.19
MSCR at 64 °C on RTFO																		
Avg % Recovery @ 3.2 kPa	62.55	64.21		61.19			60.21	61.62	64.91	62.92	62.83	58.70	62.37	63.41	63.70	66.34	64.23	66.20
Jnr @ 3.2 kPa	0.19	0.18		0.22			0.23	0.21	0.18	0.21	0.21	0.26	0.21	0.19	0.20	0.17	0.20	0.17
% Diff. between Jnr	25.42	27.30		22.84			9.57	26.21	27.95	28.69	28.52	31.50	9.35	28.54	28.00	49.17	29.44	28.03
DSR ELASTIC RECOVERY				56.10				44.10				49.70						51.00
Between 1 & 2 Std. Dev		x			x	x		x			x		x	x	x			
Greater than 2 Std Dev																		

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PG 58-28	LAB #31	LAB #32	LAB #33	LAB #34	LAB #35	LAB #36	LAB #37	LAB #38	LAB #39	AVG	2 STD DEV	1 STD DEV	STD DEV	1 STD DEV	2 STD DEV
ROTATIONAL VISCOSITY	0.300		0.273	0.279	0.300	0.264	0.290	0.370	0.286	0.3268	-0.0291	0.1488	0.1780	0.5048	0.6828
PENETRATION			126	136	110	126	142		135	133.333	118.831	126.082	7.251	140.584	147.835
COMPLEX MODULUS	1.28	1.28	1.25	1.20	1.15	1.16	1.16	1.10	1.19	1.201	1.108	1.155	0.046	1.248	1.294
PHASE ANGLE	86.8	84.2	86.8	87.1	87.0	87.0	87.0	86.9	86.9	86.83	85.93	86.38	0.45	87.28	87.73
ORIGINAL DSR	1.28	1.29	1.25	1.20	1.15	1.16	1.16	1.10	1.19	1.203	1.107	1.155	0.048	1.251	1.299
COMPLEX MODULUS			3.51	3.30	3.80	3.34	3.02	3.64	3.59	3.382	3.027	3.204	0.177	3.559	3.736
PHASE ANGLE			82.2	82.6	81.4	82.6	83.0	81.4	82.1	82.37	81.73	82.05	0.32	82.69	83.00
RTFO DSR			3.55	3.33	3.85	3.36	3.04	3.70	3.62	3.430	3.089	3.259	0.171	3.601	3.772
MASS CHANGE %			-0.304	-0.256	-0.173	-0.346	-0.272	-0.370	-0.339	-0.334	-0.460	-0.397	0.063	-0.271	-0.208
PAV WITH VDO															
PHASE ANGLE			44.1	44.6	44.9	44.4	44.1	41.8	49.4	44.148	42.960	43.554	0.594	44.741	45.335
PAV DSR			3760	3602	3460	4384	3990	5820	1823	3690.344	2907.286	3298.815	391.529	4081.873	4473.402
ESTIMATED STIFF 1			168	169	159	178	178	239	174	176.8	158.4	167.6	9.2	186.0	195.2
ESTIMATED STIFF 2			167	170	169	177	173	214	175	176.4	156.4	166.4	10.0	186.4	196.5
AVERAGE EST STIFF			167.5	169.5	164.0	177.5	175.5	226.5		175.0	157.2	166.1	8.9	183.9	192.8
RANGE			1	-1	-10	1	5	25		-0.4	-14.8	-7.6	7.2	6.8	14.0
M-VALUE 1			0.328	0.322	0.329	0.314	0.320	0.278	0.322	0.317	0.302	0.309	0.008	0.325	0.332
M-VALUE 2			0.326	0.323	0.325	0.310	0.327	0.280	0.323	0.318	0.305	0.312	0.007	0.325	0.332
AVERAGE M-VALUE			0.327	0.323	0.327	0.312	0.324	0.279		0.3186	0.3050	0.3118	0.0068	0.3254	0.3322
RANGE			0.002	-0.001	0.004	0.004	-0.007	-0.002		-0.0013	-0.0097	-0.0055	0.0042	0.0029	0.0071

PG 76-22M										AVG	2 STD DEV	1 STD DEV	STD DEV	1 STD DEV	2 STD DEV
ROTATIONAL VISCOSITY	1.350		1.300	1.344	1.342	1.290	1.327	1.610	1.388	1.3380	1.1746	1.2563	0.0817	1.4197	1.5013
COMPLEX MODULUS	1.39	1.34	1.30	1.32	1.22	1.32	1.25	1.20	1.34	1.332	1.014	1.173	0.159	1.491	1.650
PHASE ANGLE	73.0	70.6	73.1	73.4	73.3	73.5	73.6	73.2	73.4	73.18	72.05	72.62	0.57	73.75	74.32
ORIGINAL DSR	1.46	1.42	1.36	1.37	1.28	1.38	1.31	1.30	1.40	1.392	1.053	1.222	0.170	1.562	1.732
COMPLEX MODULUS			3.20	3.19	3.05	3.08	2.80	3.50	3.09	3.216	2.304	2.760	0.456	3.672	4.128
PHASE ANGLE			66.0	66.3	66.2	66.7	67.0	65.1	66.6	66.22	65.21	65.72	0.51	66.73	67.24
RTFO DSR			3.50	3.49	3.33	3.35	3.04	3.90	3.37	3.516	2.488	3.002	0.514	4.030	4.544
ELASTIC RECOVERY			76.3	73.5	75.0	74.6			76.3	75.7	72.4	74.0	1.6	77.3	78.9
PAV WITH VDO															
PHASE ANGLE			48.7	48.4	48.2	48.5	48.8	43.9	48.8	47.9	45.3	46.6	1.3	49.2	50.5
PAV DSR			1890	1997	1880	2203	3990	4070	1925	2194.7	1024.2	1609.4	585.2	2779.9	3365.1
ESTIMATED STIFF 1			151	155	178	172	152	187	163	164.5	144.0	154.2	10.3	174.8	185.0
ESTIMATED STIFF 2			154	157	158	172	153	187	163	164.6	143.7	154.1	10.4	175.0	185.5
AVERAGE EST STIFF			152.5	156.0	168.0	172.0	152.5	187.0		163.9	144.7	154.3	9.6	173.4	183.0
RANGE			-3	-2	20	0	-1	0		-0.1	-15.5	-7.8	7.7	7.6	15.3
M-VALUE 1			0.338	0.319	0.309	0.315	0.324	0.270	0.328	0.318	0.301	0.310	0.008	0.326	0.334
M-VALUE 2			0.329	0.321	0.309	0.310	0.321	0.290	0.331	0.318	0.303	0.310	0.007	0.325	0.332
AVERAGE M-VALUE			0.334	0.320	0.309	0.313	0.323	0.280		0.3185	0.3033	0.3109	0.0076	0.3261	0.3337
RANGE			0.009	-0.002	0.000	0.005	0.003	-0.020		0.0010	-0.0045	-0.0017	0.0028	0.0038	0.0066
MSCR at 64 °C on Original															
Avg % Recovery @ 3.2 kPa			34.52	32.87	35.55	33.24	30.85	33.10	32.80	33.181	27.815	30.498	2.683	35.864	38.547
Jnr @ 3.2 kPa			34.12	1.09	0.98	1.10	1.21	1.10	1.10	2.087	-9.588	-3.750	5.838	7.925	13.762
% Diff. between Jnr			47.82	55.63	37.39	39.47	38.00	39.60	47.30	46.157	31.839	38.998	7.159	53.316	60.474
MSCR at 64 °C on RTFO															
Avg % Recovery @ 3.2 kPa			64.67	65.26	63.81	63.02	60.58	66.20	63.80	63.721	59.700	61.710	2.010	65.731	67.741
Jnr @ 3.2 kPa			0.19	0.19	0.20	0.19	0.24	0.20	0.20	0.198	0.151	0.174	0.023	0.221	0.244
% Diff. between Jnr			28.85	38.38	9.90	8.65	13.39	10.90	29.10	24.681	4.609	14.645	10.036	34.718	44.754
DSR ELASTIC RECOVERY				61.00						53.23	43.125	48.177	5.052	58.280	63.332
Between 1 & 2 Std. Dev		x	x				x	x							
Greater than 2 Std Dev															