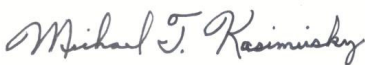


MEMORANDUM: 19-022

DATE: May 16, 2019

TO: Bob Campbell, Chairman, Rating Surveillance Panel
Pat Lang, Chairman, Technical Guidance Committee
Robert Stockwell, Chairman, Sequence III Surveillance Panel
Andy Ritchie, Chairman, Sequence V Surveillance Panel
Jim Gutzwiller, Chairman, CAT Surveillance Panel
Tim Cushing, GMOD Test Team
Rating Surveillance Panel

FROM: Michael T. Kasimirsky 

SUBJECT: LED Rating Light Study Results

As part of the Spring 2019 Light Duty Rating Workshop, a study was conducted to evaluate the use of LED rating lights in place of the current fluorescent lights used for piston deposit ratings. The intent of this study was to provide rating data on parts using both light sources and the data analyzed to determine what, if any, impact the change to LED lighting would have on testing activities in the industry.

Exercise Overview

For this exercise, the TMC converted two rating fixtures of each type (“round” and “two bulb”) to LED lighting using a commercially available LED conversion kits appropriate for each fixture.

“Round” fixtures are used in Sequence III ratings, along with most other types of deposit ratings, while the “two bulb” fixtures are used in Sequence V piston skirt ratings. These two types of fixtures encompass all non-sludge deposit ratings made at both the Light Duty Rating Workshop and Heavy Duty Rating Workshop, conducted annually by TMC.

Two rating booths were set up for this exercise at the workshop. One booth contained “round” fixtures of each type (LED and fluorescent), while the second booth contained “two bulb” fixtures of each type (LED and fluorescent).

The “round” booth contained a single Sequence IIH piston (Piston A) and a single GMOD piston (Piston B) and the “two bulb” booth contained a set of eight Sequence VH pistons (Piston Set C).

Exercise Participants

The rating data for this exercise was limited to raters who achieved a “color code” at the 2019 Light Duty Rating Workshop for the type of piston being rated. Data on Piston A & B were restricted to raters who achieved a non-yellow color code on Light Duty Piston Deposits and data on Piston Set C was restricted to raters who achieved a non-yellow color code on Sequence V Varnish. Only ratings using both types of light were included in the analysis.

The results were that 12 raters submitted data on Piston A, nine raters submitted data on Piston B, and eight raters submitted data on Piston Set C.

Data Summary

The individual rating results, along with some summary statistics for each part, are shown in the attached tables. Any individual result more than two standard deviations from the mean value is shown in red in the table.

Rating results noted in ~~red strikethrough~~ are values that are furthest from the target mean for that part or location, which are also considered “outlier observations” based upon a 99.8% significance level, as defined by ASTM Standard Practice E178 Standard Practice for Dealing With Outlying Observations. however, no screening was done to the data and these observations were **not** removed from the analysis.

There was one “outlier” rating in Groove 1 on Piston B (fluorescent rating) and one “outlier” rating in Land 3 on Piston B (LED rating) in the results. Both are almost certainly errors in recording or data entry and not actual ratings of the part location.

Calculated Ratings

From the ratings generated on each part, a summary rating was calculated and included in the analysis of each piston or set.

For Pistons A & B, a Weighted Piston Deposit (WPD) was calculated, using the following weighting percentages: 5% Groove 1, 10% Groove 2, 20% Groove 3, 15% Land 2, 30% Land 3, and 10% of the average of the thrust and anti-thrust ratings. No undercrown ratings were performed on the parts, so this rating was assumed to be 4.5 merits and weighted 10% for the WPD calculation, for all parts and raters.

For Piston Set C, an Average Piston Deposit (APV) was calculated from the eight piston skirt ratings.

Results Analysis

A preliminary review of each location on Piston A & B was made between the two light sources and the data shows comparable mean and standard deviation results for each location, regardless of lighting type. The eight piston skirts of Piston Set C were compared in a similar manner, resulting in the same conclusions. The standard deviations generated on each rating location also appear comparable to the results obtained at the workshop for these locations on other pistons of similar type rated at the workshop.

The results were further analyzed for statistical differences in the results of each rated location, based upon the lighting type used. The results for Pistons A & B are shown in Table 1 & 2, respectively, with the results for Piston Set C are shown in Table 3. Even with the known outliers included in the data set, no statistical difference was found between the ratings made with the two different light sources.

There also does not appear to be any directional correlation between the lighting type used and the rating results obtained the piston skirt ratings of Piston Set C, i.e. some LED results are mild, while others are severe, when looking at all eight pistons.

Table 1: Piston A (Sequence IIIH) Summary Data (N=24; 12 per light type)				
Rated Location	Lighting	Mean	Std. Dev.	P value
Groove 1	Fluorescent	1.37	0.431	0.8288
	LED	1.41	0.408	
Groove 2	Fluorescent	0.62	0.030	0.6240
	LED	0.62	0.036	
Groove 3	Fluorescent	9.06	0.363	0.5228
	LED	8.98	0.249	
Land 2	Fluorescent	1.06	0.091	0.4000
	LED	1.01	0.161	
Land 3	Fluorescent	0.72	0.072	0.3642
	LED	0.75	0.102	
Thrust	Fluorescent	9.86	0.057	0.7406
	LED	9.88	0.064	
Anti-Thrust	Fluorescent	9.67	0.182	0.5027
	LED	9.72	0.165	
WPD*	Fluorescent	4.24	0.090	0.8108
	LED	4.23	0.061	

*Calculated rating. Undercrown rating of 4.5 merits used. Thrust and Anti-Thrust averaged for calculation.

Table 2: Piston B (GMOD) Summary Data (N=18; 9 per light type)				
Rated Location	Lighting	Mean	Std. Dev.	P value
Groove 1	Fluorescent	2.88	2.557	0.3289
	LED	2.00	0.478	
Groove 2	Fluorescent	6.38	0.370	0.9308
	LED	6.40	0.430	
Groove 3	Fluorescent	9.44	0.268	0.3775
	LED	9.56	0.261	
Land 2	Fluorescent	0.78	0.044	0.6100
	LED	0.79	0.046	
Land 3	Fluorescent	9.02	0.208	0.4092
	LED	8.39	2.196	
Thrust	Fluorescent	9.69	0.078	0.3146
	LED	9.73	0.098	
Anti-Thrust	Fluorescent	9.92	0.024	0.3473
	LED	9.93	0.038	
WPD*	Fluorescent	7.41	0.202	0.4129
	LED	7.21	0.683	

*Calculated rating. Undercrown rating of 4.5 merits used. Thrust and Anti-Thrust averaged for calculation.

Table 3: Piston Set C (Sequence VH; 50% skirt rating) Summary Data (N=16; 8 per light type)				
Rated Location	Lighting	Mean	Std. Dev.	P value
Piston 1	Fluorescent	9.26	0.069	0.0733
	LED	9.37	0.147	
Piston 2	Fluorescent	8.23	0.363	0.6259
	LED	8.30	0.236	
Piston 3	Fluorescent	8.28	0.410	0.7014
	LED	8.35	0.280	
Piston 4	Fluorescent	9.25	0.172	0.2419
	LED	9.34	0.108	
Piston 5	Fluorescent	9.36	0.177	0.6754
	LED	9.32	0.107	
Piston 6	Fluorescent	8.60	0.268	0.8968
	LED	8.59	0.222	
Piston 7	Fluorescent	8.98	0.081	0.1438
	LED	8.88	0.169	
Piston 8	Fluorescent	8.65	0.296	0.8749
	LED	8.67	0.192	
APV*	Fluorescent	8.83	0.199	0.7544
	LED	8.85	0.129	

*Calculated rating.

Conclusion

The use of LED lighting does not appear to significantly impact the rating results obtained when compared to fluorescent lighting.

c: http://www.astmtmc.cmu.edu/ftp/docs/rater_calibration/mem19-022.mtk.pdf

Distribution: electronic mail

PARTID	PART	LIGHT	RATER	G1	G2	G3	L2	L3	TH	AT
FL-A	A	FL	Bolaney, Jonathan	1.820000052	0.639999986	9.289999962	0.889999986	0.769999981	9.880000114	9.680000305
FL-A	A	FL	Cales, Jonathon rerate	1.769999981	0.550000012	9	1.029999971	0.769999981	9.890000343	9.600000381
FL-A	A	FL	DeCapite, Vanessa	1.440000057	0.600000024	9.020000458	1.080000043	0.720000029	9.899999619	9.640000343
FL-A	A	FL	Demel, Samuel	1.379999995	0.600000024	8.710000038	0.99000001	0.620000005	9.699999809	9.899999619
FL-A	A	FL	Foecking, Brian	1.059999943	0.610000014	9.050000191	1.149999976	0.75	9.869999886	9.640000343
FL-A	A	FL	Kobrinetz, Joaquin J.	2.079999924	0.620000005	9.489999771	1.129999995	0.75999999	9.869999886	9.399999619
FL-A	A	FL	Lopez, Frank	0.75	0.620000005	9.239999771	0.99000001	0.680000007	9.899999619	9.460000038
FL-A	A	FL	Price, Gregory	1.409999967	0.620000005	8.880000114	1.090000033	0.709999979	9.920000076	9.619999886
FL-A	A	FL	Rodriguez, Jesus (Jesse)	0.860000014	0.660000026	8.270000458	1.090000033	0.790000021	9.880000114	9.470000267
FL-A	A	FL	Sanchez, Arthur rerate	0.800000012	0.660000026	9.659999847	1.169999957	0.800000012	9.899999619	9.81000042
FL-A	A	FL	Sanchez, Christopher	1.399999976	0.600000024	8.930000305	0.939999998	0.620000005	9.890000343	9.989999771
FL-A	A	FL	Trevino, Robert	1.690000057	0.620000005	9.18999958	1.159999967	0.589999974	9.909999847	9.819999695
FL-B	B	FL	Cales, Jonathon rerate	1.629999995	6.190000057	9.680000305	0.74000001	8.880000114	9.619999886	9.899999619
FL-B	B	FL	DeCapite, Vanessa	2.619999886	6.119999886	9.199999809	0.829999983	8.789999962	9.609999657	9.899999619
FL-B	B	FL	Foecking, Brian	1.669999957	6	9.789999962	0.75	9.020000458	9.619999886	9.949999809
FL-B	B	FL	Kobrinetz, Joaquin J.	1.789999962	6.460000038	9.170000076	0.75	9.31000042	9.729999542	9.949999809
FL-B	B	FL	Lopez, Frank	9.600000381	6.789999962	9.649999619	0.839999974	9.109999657	9.649999619	9.899999619
FL-B	B	FL	Rodriguez, Jesus (Jesse)	1.529999971	5.909999847	9.369999886	0.75	8.680000305	9.770000458	9.899999619
FL-B	B	FL	Sanchez, Arthur rerate	2.319999933	6.71999979	9.029999733	0.75	9.079999924	9.640000343	9.899999619
FL-B	B	FL	Sanchez, Christopher	2.039999962	6.280000021	9.43999958	0.839999974	9.020000458	9.75	9.899999619
FL-B	B	FL	Trevino, Robert	2.690000057	6.949999809	9.659999847	0.75	9.270000458	9.819999695	9.93999958
LD-A	A	LD	Bolaney, Jonathan	1.970000029	0.649999976	9.260000229	0.910000026	0.790000021	9.890000343	9.670000076
LD-A	A	LD	Cales, Jonathon rerate	1.899999976	0.579999983	8.479999542	0.879999995	0.970000029	9.899999619	9.600000381
LD-A	A	LD	DeCapite, Vanessa	1.549999952	0.639999986	8.970000267	1.120000005	0.769999981	9.899999619	9.899999619
LD-A	A	LD	Demel, Samuel	1.379999995	0.610000014	8.880000114	1.059999943	0.620000005	9.699999809	9.899999619
LD-A	A	LD	Foecking, Brian	1.370000005	0.569999993	8.989999771	1.149999976	0.800000012	9.840000153	9.630000114
LD-A	A	LD	Kobrinetz, Joaquin J.	1.789999962	0.629999995	9.399999619	1.049999952	0.769999981	9.920000076	9.539999962
LD-A	A	LD	Lopez, Frank	0.75	0.610000014	9.109999657	1.00999999	0.680000007	9.899999619	9.43999958
LD-A	A	LD	Price, Gregory	1.539999962	0.589999974	9.109999657	1.110000014	0.75	9.960000038	9.699999809
LD-A	A	LD	Rodriguez, Jesus (Jesse)	0.899999976	0.670000017	8.829999924	0.980000019	0.790000021	9.890000343	9.619999886
LD-A	A	LD	Sanchez, Arthur rerate	0.800000012	0.689999998	8.81000042	1.289999962	0.800000012	9.899999619	9.800000191
LD-A	A	LD	Sanchez, Christopher	1.379999995	0.610000014	8.75	0.949999988	0.639999986	9.890000343	9.989999771
LD-A	A	LD	Trevino, Robert	1.580000043	0.629999995	9.149999619	0.649999976	0.600000024	9.920000076	9.819999695
LD-B	B	LD	Cales, Jonathon rerate	1.659999967	6.780000021	9.659999847	0.839999974	9.170000076	9.619999886	9.899999619
LD-B	B	LD	DeCapite, Vanessa	2.210000038	6.079999924	9.06000042	0.829999983	8.970000267	9.609999657	9.899999619
LD-B	B	LD	Foecking, Brian	2.039999962	6.300000191	9.840000153	0.75	8.960000038	9.699999809	9.949999809
LD-B	B	LD	Kobrinetz, Joaquin J.	1.970000029	6.039999962	9.390000343	0.75	9.260000229	9.789999962	9.960000038
LD-B	B	LD	Lopez, Frank	1.080000043	6.829999924	9.81000042	0.839999974	9.279999733	9.68999958	9.899999619
LD-B	B	LD	Rodriguez, Jesus (Jesse)	1.75999999	5.75	9.720000267	0.75	2.549999952	9.789999962	9.899999619
LD-B	B	LD	Sanchez, Arthur rerate	2.579999924	6.449999809	9.350000381	0.75	8.93999958	9.670000076	9.899999619
LD-B	B	LD	Sanchez, Christopher	2.079999924	6.260000229	9.43999958	0.839999974	9.100000381	9.850000381	10
LD-B	B	LD	Trevino, Robert	2.650000095	7.079999924	9.739999771	0.75	9.319999695	9.880000114	9.960000038

PARTID	PART	LIGHT	RATER	P1	P2	P3	P4	P5	P6	P7	P8
FL-C1-8	C	FL	Foecking, Brian	9.319999695	7.96999979	7.840000153	8.979999542	9.06000042	8.569999695	8.840000153	8.239999771
FL-C1-8	C	FL	Kobrinetz, Joaquin J.	9.270000458	8.31000042	8.239999771	9.350000381	9.529999733	8.729999542	9.109999657	8.949999809
FL-C1-8	C	FL	Lopez, Frank	9.31000042	8.31000042	8.569999695	9.229999542	9.489999771	8.640000343	9.050000191	8.609999657
FL-C1-8	C	FL	Price, Gregory	9.25	8.300000191	8.31000042	9.430000305	9.479999542	8.539999962	8.970000267	8.68999958
FL-C1-8	C	FL	Rodriguez, Jesus (Jesse)	9.180000305	7.440000057	7.559999943	9.06000042	9.180000305	7.989999771	8.920000076	8.18999958
FL-C1-8	C	FL	Sanchez, Arthur rerate	9.350000381	8.539999962	8.75	9.43999958	9.520000458	8.739999771	8.970000267	8.829999924
FL-C1-8	C	FL	Sanchez, Christopher	9.270000458	8.470000267	8.680000305	9.159999847	9.31000042	8.859999657	9	8.960000038
FL-C1-8	C	FL	Trevino, Robert	9.149999619	8.470000267	8.270000458	9.350000381	9.270000458	8.739999771	8.960000038	8.75
LD-C1-8	C	LD	Foecking, Brian	9.329999924	8.109999657	8.039999962	9.340000153	9.180000305	8.329999924	8.720000267	8.369999886
LD-C1-8	C	LD	Kobrinetz, Joaquin J.	9.279999733	8.31000042	8.550000191	9.329999924	9.470000267	8.869999886	8.989999771	8.739999771
LD-C1-8	C	LD	Lopez, Frank	9.479999542	8.100000381	8.420000076	9.229999542	9.449999809	8.619999886	9.050000191	8.75
LD-C1-8	C	LD	Price, Gregory	9.619999886	8.579999924	8.670000076	9.5	9.369999886	8.659999847	9.06000042	8.899999619
LD-C1-8	C	LD	Rodriguez, Jesus (Jesse)	9.520000458	7.989999771	7.920000076	9.420000076	9.369999886	8.210000038	8.659999847	8.699999809
LD-C1-8	C	LD	Sanchez, Arthur rerate	9.289999962	8.220000267	8.199999809	9.260000229	9.25	8.520000458	8.670000076	8.380000114
LD-C1-8	C	LD	Sanchez, Christopher	9.270000458	8.520000458	8.659999847	9.18999958	9.220000267	8.699999809	8.880000114	8.760000229
LD-C1-8	C	LD	Trevino, Robert	9.199999809	8.590000153	8.31000042	9.430000305	9.279999733	8.770000458	8.970000267	8.779999733

LIGHT DUTY RATING WORKSHOP (May 6-10, 2019)

Part ID= FL-A - SEQUENCE IIH PISTON

Rated Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	G1TOT	G2TOT	G3TOT	L2TOT	L3TOT	FRTOT	RRTOT	
Bolaney, Jonathan	1.82	0.64	9.29	0.89	0.77	9.88	9.68	
Cales, Jonathon rerate	1.77	0.55	9.00	1.03	0.77	9.89	9.60	
DeCapite, Vanessa	1.44	0.60	9.02	1.08	0.72	9.90	9.64	
Demel, Samuel	1.38	0.60	8.71	0.99	0.62	9.70	9.90	
Foecking, Brian	1.06	0.61	9.05	1.15	0.75	9.87	9.64	
Kobrinetz, Joaquin J.	2.08	0.62	9.49	1.13	0.76	9.87	9.40	
Lopez, Frank	0.75	0.62	9.24	0.99	0.68	9.90	9.46	
Price, Gregory	1.41	0.62	8.88	1.09	0.71	9.92	9.62	
Rodriguez, Jesus (Jesse)	0.86	0.66	8.27	1.09	0.79	9.88	9.47	
Sanchez, Arthur rerate	0.80	0.66	9.66	1.17	0.80	9.90	9.81	
Sanchez, Christopher	1.40	0.60	8.93	0.94	0.62	9.89	9.99	
Trevino, Robert	1.69	0.62	9.19	1.16	0.59	9.91	9.82	
MAXIMUM	2.08	0.66	9.66	1.17	0.80	9.92	9.99	
MINIMUM	0.75	0.55	8.27	0.89	0.59	9.70	9.40	
RANGE(MAX-MIN)	1.330	0.110	1.390	0.280	0.210	0.220	0.590	
MEAN	1.372	0.617	9.061	1.059	0.715	9.876	9.669	
STANDARD DEVIATION	0.431	0.100	0.363	0.100	0.100	0.100	0.182	
N SIZE	12.000							

Part ID= FL-A - SEQUENCE IIH PISTON

FL-A Yi Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	G1TOT	G2TOT	G3TOT	L2TOT	L3TOT	FRTOT	RRTOT	
Bolaney, Jonathan	1.04	0.23	0.63	-1.69	0.55	0.04	0.06	
Cales, Jonathon rerate	0.92	-0.67	-0.17	-0.29	0.55	0.14	-0.38	
DeCapite, Vanessa	0.16	-0.17	-0.11	0.21	0.05	0.24	-0.16	
Demel, Samuel	0.02	-0.17	-0.97	-0.69	-0.95	-1.76	1.27	
Foecking, Brian	-0.72	-0.07	-0.03	0.91	0.35	-0.06	-0.16	
Kobrinetz, Joaquin J.	1.64	0.03	1.18	0.71	0.45	-0.06	-1.48	
Lopez, Frank	-1.44	0.03	0.49	-0.69	-0.35	0.24	-1.15	
Price, Gregory	0.09	0.03	-0.50	0.31	-0.05	0.44	-0.27	
Rodriguez, Jesus (Jesse)	-1.19	0.43	-2.18	0.31	0.75	0.04	-1.10	
Sanchez, Arthur rerate	-1.33	0.43	1.65	1.11	0.85	0.24	0.77	
Sanchez, Christopher	0.07	-0.17	-0.36	-1.19	-0.95	0.14	1.76	
Trevino, Robert	0.74	0.03	0.36	1.01	-1.25	0.34	0.83	
MAXIMUM	1.64	-0.67	-2.18	-1.69	-1.25	-1.76	1.76	
MINIMUM	0.02	0.03	-0.03	0.21	0.05	0.04	0.06	
RANGE(MAX-MIN)	1.625	-0.700	-2.150	-1.900	-1.300	-1.800	1.705	
MEAN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
STANDARD DEVIATION	1.000	0.296	1.000	0.911	0.720	0.574	1.000	
N SIZE	12.000							

LIGHT DUTY RATING WORKSHOP (May 6-10, 2019)

Part ID= LED-A - SEQUENCE IIH PISTON

Rated Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	G1TOT	G2TOT	G3TOT	L2TOT	L3TOT	FRTOT	RRTOT	
Bolaney, Jonathan	1.97	0.65	9.26	0.91	0.79	9.89	9.67	
Cales, Jonathon rerate	1.90	0.58	8.48	0.88	0.97	9.90	9.60	
DeCapite, Vanessa	1.55	0.64	8.97	1.12	0.77	9.90	9.90	
Demel, Samuel	1.38	0.61	8.88	1.06	0.62	9.70	9.90	
Foecking, Brian	1.37	0.57	8.99	1.15	0.80	9.84	9.63	
Kobrinetz, Joaquin J.	1.79	0.63	9.40	1.05	0.77	9.92	9.54	
Lopez, Frank	0.75	0.61	9.11	1.01	0.68	9.90	9.44	
Price, Gregory	1.54	0.59	9.11	1.11	0.75	9.96	9.70	
Rodriguez, Jesus (Jesse)	0.90	0.67	8.83	0.98	0.79	9.89	9.62	
Sanchez, Arthur rerate	0.80	0.69	8.81	1.29	0.80	9.90	9.80	
Sanchez, Christopher	1.38	0.61	8.75	0.95	0.64	9.89	9.99	
Trevino, Robert	1.58	0.63	9.15	0.65	0.60	9.92	9.82	
MAXIMUM	1.97	0.69	9.40	1.29	0.97	9.96	9.99	
MINIMUM	0.75	0.57	8.48	0.65	0.60	9.70	9.44	
RANGE(MAX-MIN)	1.220	0.120	0.920	0.640	0.370	0.260	0.550	
MEAN	1.409	0.623	8.978	1.013	0.748	9.884	9.718	
STANDARD DEVIATION	0.408	0.100	0.249	0.161	0.102	0.100	0.165	
N SIZE	12.000							

Part ID= LED-A - SEQUENCE IIH PISTON

LED-A Yi Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	G1TOT	G2TOT	G3TOT	L2TOT	L3TOT	FRTOT	RRTOT	
Bolaney, Jonathan	1.37	0.27	1.13	-0.64	0.41	0.06	-0.29	
Cales, Jonathon rerate	1.20	-0.43	-2.00	-0.83	2.18	0.16	-0.71	
DeCapite, Vanessa	0.34	0.17	-0.03	0.66	0.21	0.16	1.10	
Demel, Samuel	-0.07	-0.13	-0.39	0.29	-1.26	-1.84	1.10	
Foecking, Brian	-0.10	-0.53	0.05	0.85	0.51	-0.44	-0.53	
Kobrinetz, Joaquin J.	0.93	0.07	1.69	0.23	0.21	0.36	-1.07	
Lopez, Frank	-1.61	-0.13	0.53	-0.02	-0.67	0.16	-1.68	
Price, Gregory	0.32	-0.33	0.53	0.60	0.02	0.76	-0.11	
Rodriguez, Jesus (Jesse)	-1.25	0.47	-0.60	-0.21	0.41	0.06	-0.59	
Sanchez, Arthur rerate	-1.49	0.67	-0.68	1.72	0.51	0.16	0.50	
Sanchez, Christopher	-0.07	-0.13	-0.92	-0.39	-1.07	0.06	1.65	
Trevino, Robert	0.42	0.07	0.69	-2.26	-1.46	0.36	0.62	
MAXIMUM	-1.61	0.67	-2.00	-2.26	2.18	-1.84	-1.68	
MINIMUM	-0.07	0.07	-0.03	-0.02	0.02	0.06	-0.11	
RANGE(MAX-MIN)	-1.543	0.600	-1.968	-2.236	2.163	-1.900	-1.574	
MEAN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
STANDARD DEVIATION	1.000	0.358	1.000	1.000	1.000	0.642	1.000	
N SIZE	12.000							

LIGHT DUTY RATING WORKSHOP (May 6-10, 2019)

Part ID= FL-B - GMOD PISTON

Rated Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	G1TOT	G2TOT	G3TOT	L2TOT	L3TOT	THTOT	ATTOT	
Cales, Jonathon rerate	1.63	6.19	9.68	0.74	8.88	9.62	9.90	
DeCapite, Vanessa	2.62	6.12	9.20	0.83	8.79	9.61	9.90	
Foecking, Brian	1.67	6.00	9.79	0.75	9.02	9.62	9.95	
Kobrinetz, Joaquin J.	1.79	6.46	9.17	0.75	9.31	9.73	9.95	
Lopez, Frank	9.60	6.79	9.65	0.84	9.11	9.65	9.90	
Rodríguez, Jesus (Jesse)	1.53	5.91	9.37	0.75	8.68	9.77	9.90	
Sanchez, Arthur rerate	2.32	6.72	9.03	0.75	9.08	9.64	9.90	
Sanchez, Christopher	2.04	6.28	9.44	0.84	9.02	9.75	9.90	
Trevino, Robert	2.69	6.95	9.66	0.75	9.27	9.82	9.94	
MAXIMUM	2.69	6.95	9.79	0.84	9.31	9.82	9.95	
MINIMUM	1.53	5.91	9.03	0.74	8.68	9.61	9.90	
RANGE(MAX-MIN)	1.160	1.040	0.760	0.100	0.630	0.210	0.050	
MEAN	2.036	6.380	9.443	0.778	9.018	9.690	9.916	
STANDARD DEVIATION	0.457	0.370	0.268	0.100	0.208	0.100	0.100	
N SIZE	9.000							

Part ID= FL-B - GMOD PISTON

FL-B Yi Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	G1TOT	G2TOT	G3TOT	L2TOT	L3TOT	THTOT	ATTOT	
Cales, Jonathon rerate	-0.89	-0.51	0.88	-0.38	-0.66	-0.70	-0.16	
DeCapite, Vanessa	1.28	-0.70	-0.91	0.52	-1.09	-0.80	-0.16	
Foecking, Brian	-0.80	-1.03	1.29	-0.28	0.01	-0.70	0.34	
Kobrinetz, Joaquin J.	-0.54	0.22	-1.02	-0.28	1.40	0.40	0.34	
Lopez, Frank	16.53	1.11	0.77	0.62	0.44	-0.40	-0.16	
Rodríguez, Jesus (Jesse)	-1.11	-1.27	-0.27	-0.28	-1.62	0.80	-0.16	
Sanchez, Arthur rerate	0.62	0.92	-1.54	-0.28	0.30	-0.50	-0.16	
Sanchez, Christopher	0.01	-0.27	-0.01	0.62	0.01	0.60	-0.16	
Trevino, Robert	1.43	1.54	0.81	-0.28	1.21	1.30	0.24	
MAXIMUM	1.43	1.54	-1.54	0.62	-1.62	1.30	0.34	
MINIMUM	0.01	0.22	-0.01	-0.28	0.01	0.40	-0.16	
RANGE(MAX-MIN)	1.421	1.325	-1.528	0.900	-1.634	0.900	0.500	
MEAN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
STANDARD DEVIATION	1.000	1.000	1.000	0.444	1.000	0.781	0.235	
N SIZE	9.000							

LIGHT DUTY RATING WORKSHOP (May 6-10, 2019)

Part ID= LED-B - GMOD PISTON

Rated Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	G1TOT	G2TOT	G3TOT	L2TOT	L3TOT	THTOT	ATTOT	
Cales, Jonathon rerate	1.66	6.78	9.66	0.84	9.17	9.62	9.90	
DeCapite, Vanessa	2.21	6.08	9.06	0.83	8.97	9.61	9.90	
Foecking, Brian	2.04	6.30	9.84	0.75	8.96	9.70	9.95	
Kobrinetz, Joaquin J.	1.97	6.04	9.39	0.75	9.26	9.79	9.96	
Lopez, Frank	1.08	6.83	9.81	0.84	9.28	9.69	9.90	
Rodríguez, Jesus (Jesse)	1.76	5.75	9.72	0.75	2.55	9.79	9.90	
Sanchez, Arthur rerate	2.58	6.45	9.35	0.75	8.94	9.67	9.90	
Sanchez, Christopher	2.08	6.26	9.44	0.84	9.10	9.85	10.00	
Trevino, Robert	2.65	7.08	9.74	0.75	9.32	9.88	9.96	
MAXIMUM	2.65	7.08	9.84	0.84	9.32	9.88	10.00	
MINIMUM	1.08	5.75	9.06	0.75	2.55	9.61	9.90	
RANGE(MAX-MIN)	1.570	1.330	0.780	0.090	6.770	0.270	0.100	
MEAN	2.003	6.397	9.557	0.789	8.394	9.733	9.930	
STANDARD DEVIATION	0.478	0.430	0.261	0.100	2.196	0.100	0.100	
N SIZE	9.000							

Part ID= LED-B - GMOD PISTON

LED-B Yi Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	G1TOT	G2TOT	G3TOT	L2TOT	L3TOT	THTOT	ATTOT	
Cales, Jonathon rerate	-0.72	0.89	0.40	0.51	0.35	-1.13	-0.30	
DeCapite, Vanessa	0.43	-0.74	-1.90	0.41	0.26	-1.23	-0.30	
Foecking, Brian	0.08	-0.22	1.08	-0.39	0.26	-0.33	0.20	
Kobrinetz, Joaquin J.	-0.07	-0.83	-0.64	-0.39	0.39	0.57	0.30	
Lopez, Frank	-1.93	1.01	0.97	0.51	0.40	-0.43	-0.30	
Rodríguez, Jesus (Jesse)	-0.51	-1.50	0.63	-0.39	-2.66	0.57	-0.30	
Sanchez, Arthur rerate	1.21	0.12	-0.79	-0.39	0.25	-0.63	-0.30	
Sanchez, Christopher	0.16	-0.32	-0.45	0.51	0.32	1.17	0.70	
Trevino, Robert	1.35	1.59	0.70	-0.39	0.42	1.47	0.30	
MAXIMUM	-1.93	1.59	-1.90	0.51	-2.66	1.47	0.70	
MINIMUM	-0.07	0.12	0.40	-0.39	0.25	-0.33	0.20	
RANGE(MAX-MIN)	-1.860	1.466	-2.296	0.900	-2.909	1.800	0.500	
MEAN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
STANDARD DEVIATION	1.000	1.000	1.000	0.462	1.000	0.979	0.381	
N SIZE	9.000							

LIGHT DUTY RATING WORKSHOP (May 6-10, 2019)

Part ID= FL-C1-8 - SEQ. VH PISTONS

Rated Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	P1MERI	P2MERI	P3MERI	P4MERI	P5MERI	P6MERI	P7MERI	P8MERI	
Foecking, Brian	9.32	7.97	7.84	8.98	9.06	8.57	8.84	8.24	
Kobrinetz, Joaquin J.	9.27	8.31	8.24	9.35	9.53	8.73	9.11	8.95	
Lopez, Frank	9.31	8.31	8.57	9.23	9.49	8.64	9.05	8.61	
Price, Gregory	9.25	8.30	8.31	9.43	9.48	8.54	8.97	8.69	
Rodriguez, Jesus (Jesse)	9.18	7.44	7.56	9.06	9.18	7.99	8.92	8.19	
Sanchez, Arthur rerate	9.35	8.54	8.75	9.44	9.52	8.74	8.97	8.83	
Sanchez, Christopher	9.27	8.47	8.68	9.16	9.31	8.86	9.00	8.96	
Trevino, Robert	9.15	8.47	8.27	9.35	9.27	8.74	8.96	8.75	
MAXIMUM	9.35	8.54	8.75	9.44	9.53	8.86	9.11	8.96	
MINIMUM	9.15	7.44	7.56	8.98	9.06	7.99	8.84	8.19	
RANGE(MAX-MIN)	0.200	1.100	1.190	0.460	0.470	0.870	0.270	0.770	
MEAN	9.263	8.226	8.278	9.250	9.355	8.601	8.978	8.653	
STANDARD DEVIATION	0.100	0.363	0.410	0.172	0.177	0.268	0.100	0.296	
N SIZE	8.000								

Part ID= FL-C1-8 - SEQ. VH PISTONS

FL-C1-8 YI Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	P1MERI	P2MERI	P3MERI	P4MERI	P5MERI	P6MERI	P7MERI	P8MERI	
Foecking, Brian	0.58	-0.71	-1.07	-1.57	-1.67	-0.12	-1.38	-1.40	
Kobrinetz, Joaquin J.	0.08	0.23	-0.09	0.58	0.99	0.48	1.33	1.01	
Lopez, Frank	0.48	0.23	0.71	-0.12	0.76	0.14	0.73	-0.14	
Price, Gregory	-0.13	0.20	0.08	1.05	0.71	-0.23	-0.08	0.13	
Rodriguez, Jesus (Jesse)	-0.83	-2.17	-1.75	-1.11	-0.99	-2.28	-0.58	-1.57	
Sanchez, Arthur rerate	0.88	0.87	1.15	1.11	0.93	0.52	-0.08	0.60	
Sanchez, Christopher	0.08	0.67	0.98	-0.52	-0.25	0.97	0.23	1.04	
Trevino, Robert	-1.13	0.67	-0.02	0.58	-0.48	0.52	-0.18	0.33	
MAXIMUM	-1.13	-2.17	-1.75	-1.57	-1.67	-2.28	-1.38	-1.57	
MINIMUM	0.08	0.20	-0.02	-0.12	-0.25	-0.12	-0.08	0.13	
RANGE(MAX-MIN)	-1.200	-2.372	-1.730	-1.457	-1.415	-2.166	-1.300	-1.692	
MEAN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
STANDARD DEVIATION	0.686	1.000	1.000	1.000	1.000	1.000	0.810	1.000	
N SIZE	8.000								

LIGHT DUTY RATING WORKSHOP (May 6-10, 2019)

Part ID= LED-C1-8 - SEQ. VH PISTONS

Rated Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	P1MERI	P2MERI	P3MERI	P4MERI	P5MERI	P6MERI	P7MERI	P8MERI	
Foecking, Brian	9.33	8.11	8.04	9.34	9.18	8.33	8.72	8.37	
Kobrinetz, Joaquin J.	9.28	8.31	8.55	9.33	9.47	8.87	8.99	8.74	
Lopez, Frank	9.48	8.10	8.42	9.23	9.45	8.62	9.05	8.75	
Price, Gregory	9.62	8.58	8.67	9.50	9.37	8.66	9.06	8.90	
Rodriguez, Jesus (Jesse)	9.52	7.99	7.92	9.42	9.37	8.21	8.66	8.70	
Sanchez, Arthur rerate	9.29	8.22	8.20	9.26	9.25	8.52	8.67	8.38	
Sanchez, Christopher	9.27	8.52	8.66	9.19	9.22	8.70	8.88	8.76	
Trevino, Robert	9.20	8.59	8.31	9.43	9.28	8.77	8.97	8.78	
MAXIMUM	9.62	8.59	8.67	9.50	9.47	8.87	9.06	8.90	
MINIMUM	9.20	7.99	7.92	9.19	9.18	8.21	8.66	8.37	
RANGE(MAX-MIN)	0.420	0.600	0.750	0.310	0.290	0.660	0.400	0.530	
MEAN	9.374	8.303	8.346	9.338	9.324	8.585	8.875	8.673	
STANDARD DEVIATION	0.147	0.236	0.280	0.108	0.107	0.222	0.169	0.192	
N SIZE	8.000								

Part ID= LED-C1-8 - SEQ. VH PISTONS

LED-C1-8 YI Values

* Denotes parameters not used in Blue, Red, White & Yellow assessment

Rater	P1MERI	P2MERI	P3MERI	P4MERI	P5MERI	P6MERI	P7MERI	P8MERI	
Foecking, Brian	-0.30	-0.82	-1.09	0.02	-1.34	-1.15	-0.92	-1.57	
Kobrinetz, Joaquin J.	-0.64	0.03	0.73	-0.07	1.36	1.28	0.68	0.35	
Lopez, Frank	0.72	-0.86	0.26	-1.00	1.18	0.16	1.04	0.40	
Price, Gregory	1.67	1.18	1.16	1.51	0.43	0.34	1.10	1.18	
Rodriguez, Jesus (Jesse)	0.99	-1.32	-1.52	0.77	0.43	-1.69	-1.27	0.14	
Sanchez, Arthur rerate	-0.57	-0.35	-0.52	-0.72	-0.69	-0.29	-1.21	-1.52	
Sanchez, Christopher	-0.70	0.92	1.12	-1.37	-0.97	0.52	0.03	0.45	
Trevino, Robert	-1.18	1.22	-0.13	0.86	-0.41	0.83	0.56	0.56	
MAXIMUM	1.67	-1.32	-1.52	1.51	1.36	-1.69	-1.27	-1.57	
MINIMUM	-0.30	0.03	-0.13	0.02	-0.41	0.16	0.03	0.14	
RANGE(MAX-MIN)	1.968	-1.357	-1.393	1.486	1.773	-1.846	-1.304	-1.715	
MEAN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
STANDARD DEVIATION	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
N SIZE	8.000								