IVB Prove-Out Review
Operational Data &
Average Intake Lifter Area Loss

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Feb 2016

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Data Overview

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- Operational data were collected from 101 to 102 hours of each test.
  - Each test hour contains 120 cycles (each cycle is 30 seconds)
  - Each cycle consists of 4 stages:
    - Stage 1 (7 seconds)
    - Stage 12: the transition from stage 1 to stage 2 (8 seconds)
    - Stage 2 (7 seconds)
    - Stage 21: the transition from stage 2 to stage 1 (8 seconds)

- Appendix A contains exhaust and intake lifter area and volume loss results by test

- Appendix B includes correlation plots between average intake lifter area loss studentized residuals and summarized operational data metrics

- Appendix C contains plots of the operational data

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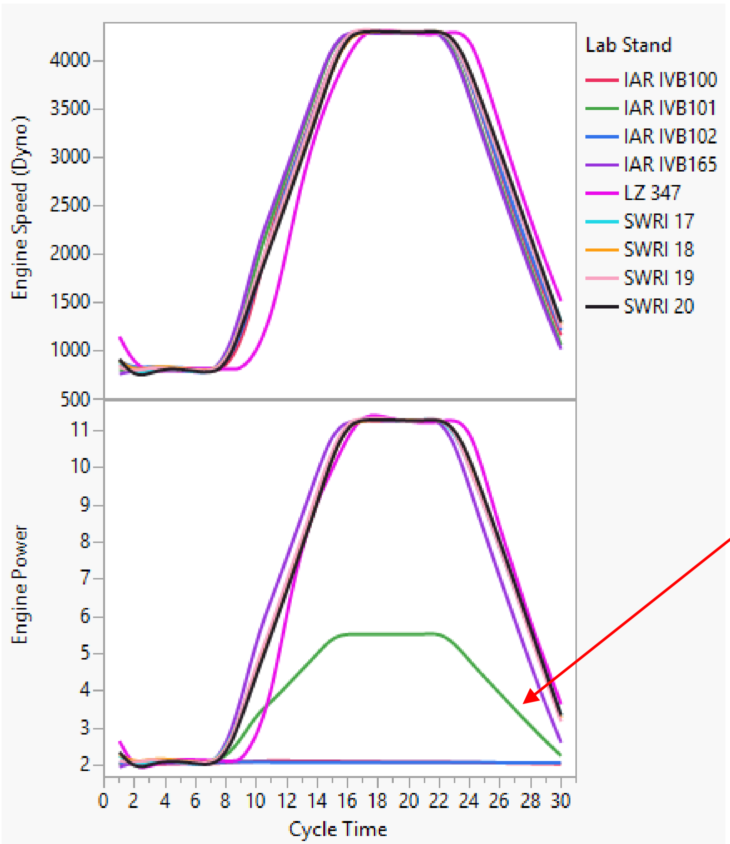
Summary

Most predominant lab differences possibly contributing to stand-to-stand severity differences:

1. There is a 1 to 2 second offset between SwRI tests and both LZ tests & early IAR tests (100-0-1, 100-0-2, 101-0-1, 102-0-1, and 102-0-2). These offsets are observed in how the following operational parameters ramp up and down throughout the cycle:

General trend depicted by lab-stand



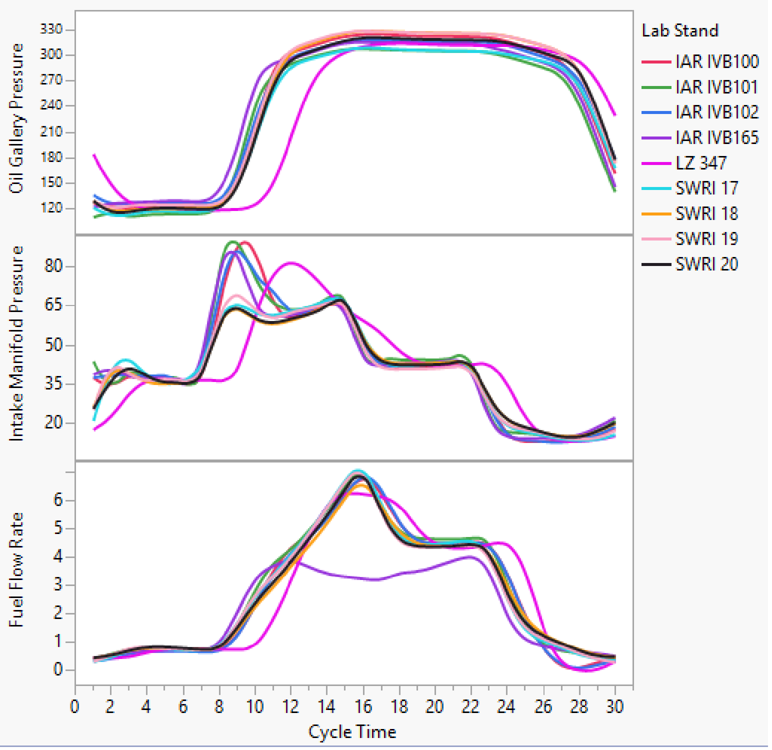
– Engine speed & engine power
  - » There is a slower increase at LZ in these operational parameters at the beginning of the transition from stage 1 to stage 2. Mid way through this transition the rate at which these operational parameters ramp up increases and LZ becomes more similar to the other labs by the beginning of stage 2.
  - » Note: Some IAR tests (including early tests listed above) don't exhibit a ramp up and down in engine power (causes general trend depicted on the left to be lower or flat).

Summary

Most predominant lab differences possibly contributing to stand-to-stand severity differences:

1. (cont.) There is a 1 to 2 second offset between SwRI tests and both LZ tests & early IAR tests (100-0-1, 100-0-2, 101-0-1, 102-0-1, and 102-0-2). These offsets are observed in how the following operational parameters ramp up and down throughout the cycle:

General trend depicted by lab-stand



- Oil gallery pressure
- Intake manifold pressure
  - » Step changes in pressure are also more gradual at LZ than other labs.
- Fuel flow rate
  - » The fuel flow rate of IAR stand 165 does not ramp as high as all other stands in the transition from stage 1 to stage 2; fuel flow in stage 2 is lower as well.
  - » Step changes in flow rate are generally more gradual at LZ than other labs.

Summary

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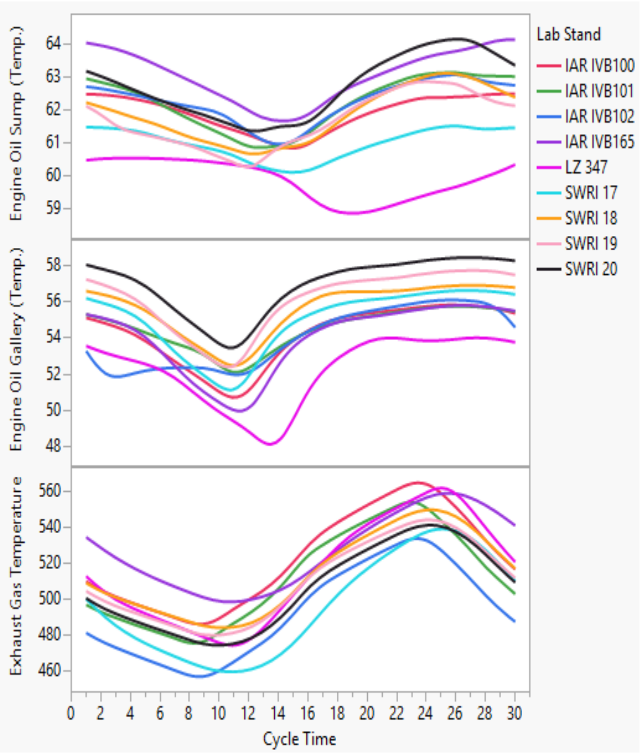
Most predominant labs differences possibly contributing to stand-to-stand severity differences:

2. The dip observed in each of the following operational parameters does not occur at the same time within the test cycle across labs.

General trend depicted by lab-stand



- Oil sump temperature
  - At IAR and SwRI, the dip occurs at the end of the transition from stage 1 to stage 2.
  - At LZ, the dip occurs in stage 2.
  - LZ also has the lowest sump temperature on average.
- Oil gallery temperature
  - LZ dips at the end of the transition from stage 1 to stage 2.
  - IAR and SwRI generally dip in the middle of this transition with IAR's dip generally occurring about 1 to 2 seconds after SwRI.
  - SwRI tends to have the highest average gallery temperature, followed IAR and then LZ with the lowest.
  - IAR stand 102 temp cycles differently than other stands.
- Exhaust gas temperature
  - The dip at IAR occurs ~3 seconds prior to LZ and SwRI (with the exception of stand 165 which tracks 1 or 2 seconds behind LZ and SwRI).
  - LZ and SwRI17 have the steepest stage 1 and 2 slopes.

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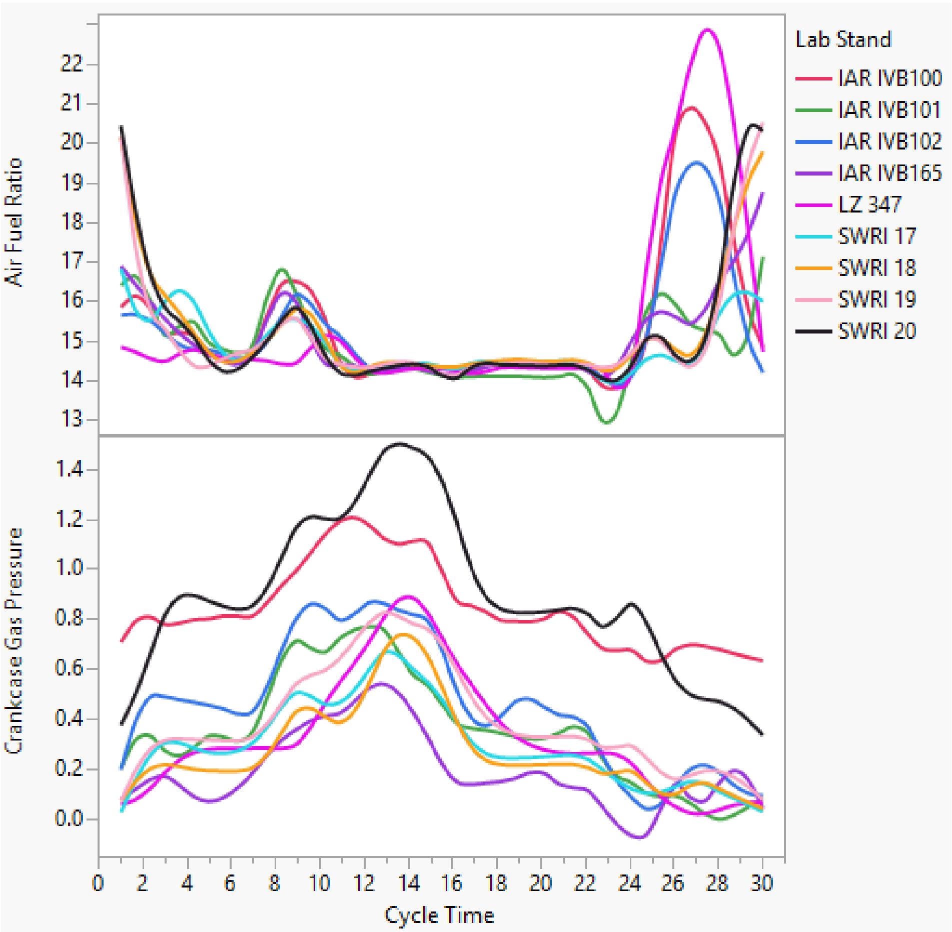
Summary

Most predominant lab differences possibly contributing to stand-to-stand severity differences:

General trend depicted by lab-stand



3. At LZ the air fuel ratio generally spikes up and then back down in the transition from stage 2 to stage 1 while at SwRI the air fuel ratio spikes up at the end of the transition and then spikes down at the beginning of stage 1.

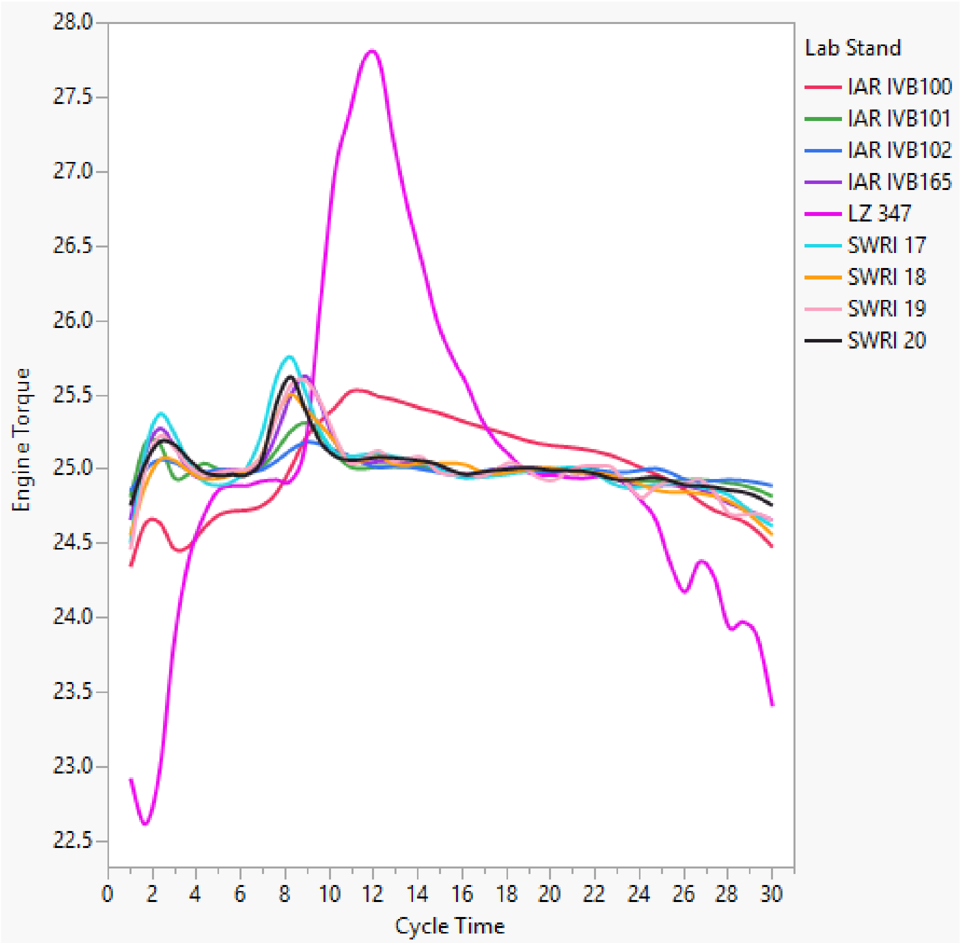
   There is also a spike in air fuel ratio at IAR and SwRI at the beginning of the transition from stage 1 to stage 2 whereas LZ spikes a few seconds later.

4. The spike in crankcase gas pressure in the transition from stage 1 to 2 generally happens a few seconds sooner at IAR than LZ and SwRI.

Summary

Most predominant lab differences possibly contributing to stand-to-stand severity differences:

General trend depicted by lab-stand

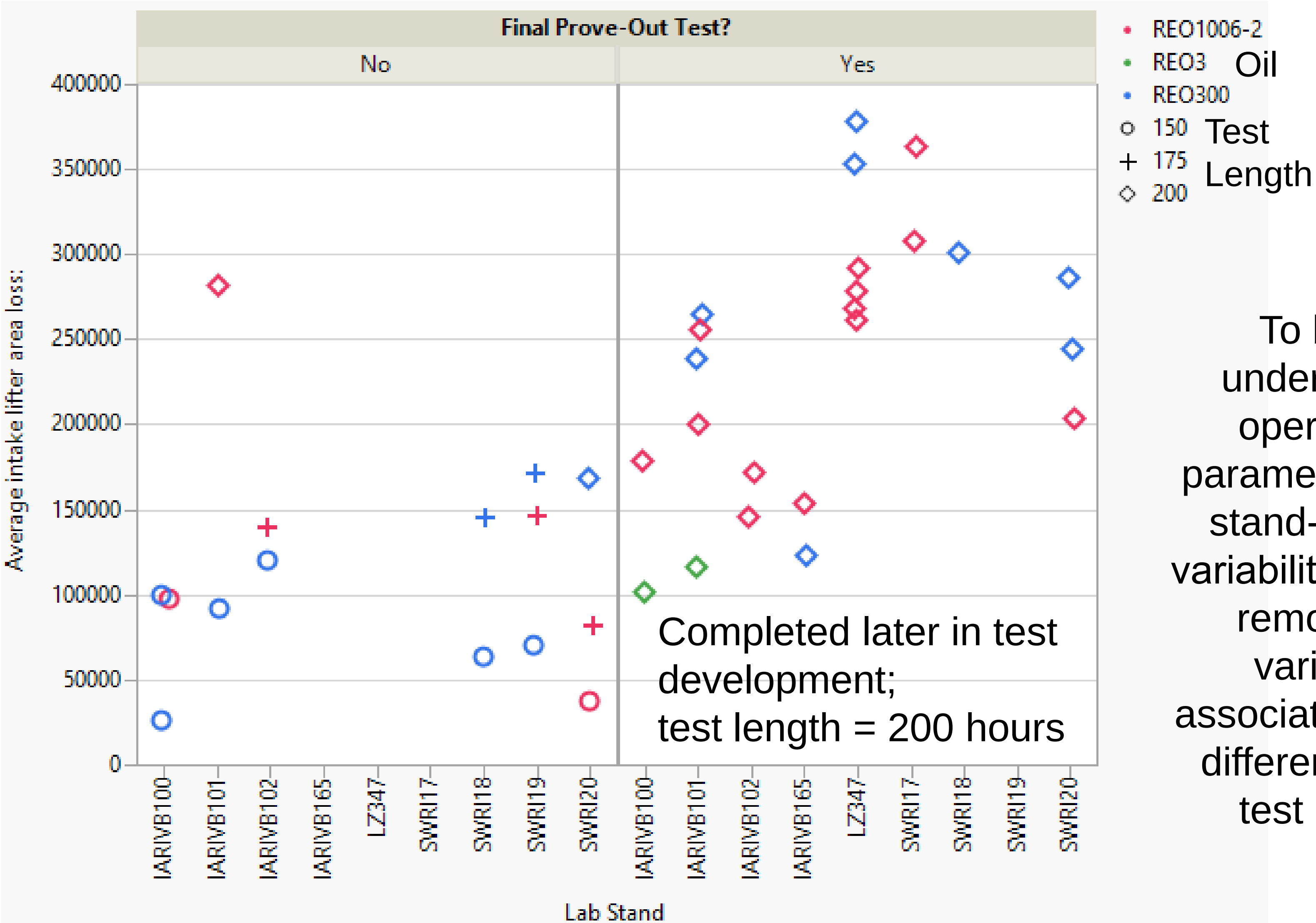


5. The spike in engine torque at LZ occurs in the middle of the transition from stage 1 to stage 2 and in some tests is much higher than the spike observed at the other labs.

   SwRI's torque spikes the first second of the transition from stage 1 to stage 2 while IAR is generally 1 second behind.

   LZ also has a dip in torque at the beginning of stage 1 (this is not observed at the other labs).

Average Intake Lifter Area Loss



To better understand if operational parameters affect stand-to-stand variability, let's first remove the variability associated with oil differences and test length.

Data can be found in Appendix A

Average Intake Lifter Area Loss - Residuals

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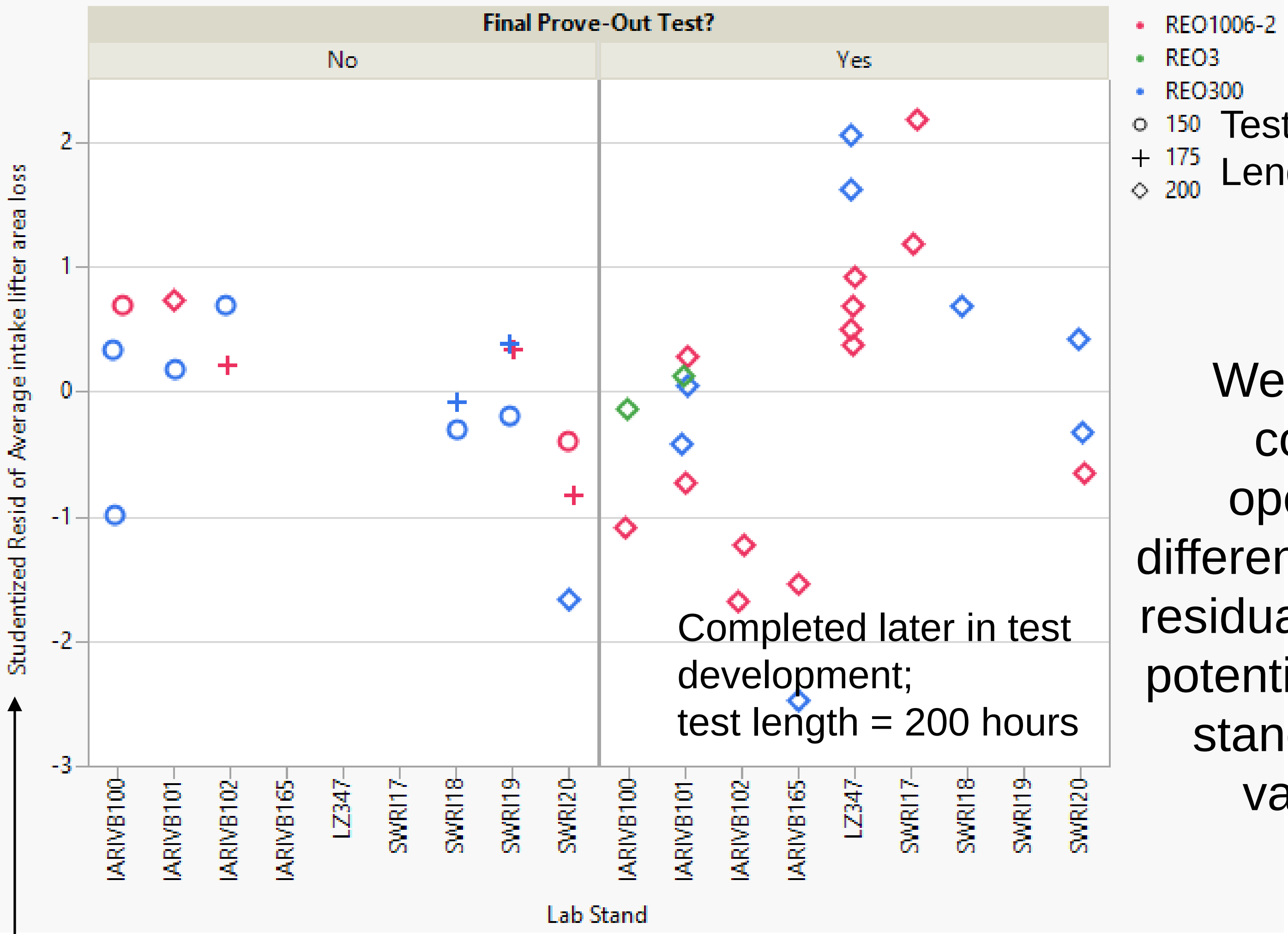

Oil

Test Length

We can then correlate operational differences to these residuals to identify potential causes of stand-to-stand variability.

Studentized residual is a measure of the remaining variability in data after oil differences and the test length effect are taken into account.

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Summary Table of Possible Operational Differences Affecting Average Intake Lifter Area Loss (More Detail in Appendix B)

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Stage	Lab Stand	Average Engine Speed (Dyno)	Average Engine Speed Median (Dyno)	Average Engine Speed Std dev (Dyno)	Average Engine Speed Slope (Dyno)	AverageEngine Speed (Flywheel)	Average Engine Speed Median (Flywheel)	Average Engine Speed Std Dev (Flywheel)	Average Engine Speed Slope (Flywheel)	Average Engine Oil Sump Temp	Average Engine Oil Sump Temp Median	Average Engine Oil Sump Temp Std Dev	Average Engine Oil Sump Temp Slope	Average Engine Oil Gallery Temp Std Dev	Average Engine Oil Gallery Temp Slope
1	IARIVB100	807.2	798.6	56.3	-6.6	807.8	801.2	58.0	-6.51	62.3	62.4	0.231	-0.077	0.82	-0.40
1	IARIVB101	807.0	804.8	34.5	-0.2	806.8	806.2	38.7	0.07	62.5	62.6	0.418	-0.168	0.58	-0.27
1	IARIVB102	836.3	822.5	49.8	-9.3	685.6	670.1	83.1	0.60	62.5	62.5	0.280	-0.088	0.50	-0.08
1	IARIVB165	790.3	794.1	19.8	3.8	790.0	793.7	23.3	3.59	63.7	63.7	0.410	-0.158	0.99	-0.47
1	LZ347	**877.8**	**835.0**	**124.7**	**-42.4**	879.2	836.2	**125.0**	**-42.59**	60.5	60.5	**0.132**	**0.004**	0.58	-0.28
1	SWRI17	812.8	806.0	41.5	-7.7					61.3	61.4	0.288	-0.073	1.02	-0.49
1	SWRI18	832.1	820.7	35.0	-9.4					61.8	61.8	0.362	-0.146	0.76	-0.36
1	SWRI19	814.3	812.2	21.0	-2.7					61.5	61.4	0.415	-0.177	1.01	-0.49
1	SWRI20	806.6	798.3	51.9	-10.1					62.7	62.7	0.417	-0.178	0.85	-0.41
12	IARIVB100	2420.9	2491.8	1075.1	467.3	2423.7	2496.7	1075.3	467.37	61.3	61.3	0.396	-0.151	1.15	0.28
12	IARIVB101	2560.9	2611.3	1066.4	464.0	2564.0	2614.4	1067.0	464.33	61.2	61.1	0.390	-0.112	0.90	**0.08**
12	IARIVB102	2425.0	2483.0	1047.2	455.1	2402.1	2486.0	1083.6	471.09	61.5	61.5	0.512	-0.185	0.71	0.20
12	IARIVB165	2629.3	2670.9	1045.8	455.2	2630.3	2671.6	1045.9	455.26	62.2	62.1	0.573	-0.188	1.19	0.27
12	LZ347	**2029.8**	**1750.1**	1106.8	470.2	**2033.9**	**1753.6**	1109.3	471.31	60.3	60.3	0.275	-0.095	1.07	**-0.33**
12	SWRI17	2404.0	2391.0	995.9	434.4					60.5	60.5	0.421	-0.133	1.27	0.40
12	SWRI18	2386.6	2371.0	989.0	431.3					60.9	60.9	0.262	-0.046	0.97	0.25
12	SWRI19	2439.4	2432.7	1020.0	444.8					60.7	60.7	0.315	0.015	1.32	0.44
12	SWRI20	2358.2	2338.4	1000.4	436.2					61.6	61.6	0.292	-0.071	1.09	0.31
2	IARIVB100	4290.7	4294.9	24.5	4.9	4292.1	4296.2	24.3	4.86	61.7	61.7	0.425	0.204	0.38	0.18
2	IARIVB101	4296.4	4301.4	18.6	3.4	4298.4	4303.3	18.5	3.39	62.2	62.3	0.546	0.261	0.37	0.17
2	IARIVB102	4300.4	4306.3	22.5	3.9	4301.7	4307.4	22.2	3.84	62.2	62.2	0.466	0.225	0.46	0.22
2	IARIVB165	4292.7	4293.5	12.0	1.3	4293.8	4294.6	11.9	1.32	62.7	62.8	0.500	0.236	0.43	0.19
2	LZ347	4267.5	4298.4	**96.0**	**23.9**	4276.3	4307.1	**96.0**	**23.89**	**59.1**	**59.0**	**0.246**	**-0.032**	**1.05**	**0.48**
2	SWRI17	4298.9	4305.5	19.1	4.6					60.7	60.8	0.380	0.169	0.37	0.16
2	SWRI18	4292.0	4302.7	28.1	9.4					61.9	62.0	0.607	0.291	0.27	0.09
2	SWRI19	4309.3	4312.5	14.5	1.3					62.0	62.1	0.534	0.252	0.31	0.13
2	SWRI20	4294.6	4303.5	26.1	7.6					62.8	62.9	0.715	0.346	0.35	0.15
21	IARIVB100	2655.8	2630.7	1006.5	-438.6	2655.1	2631.2	1006.5	-438.65	62.4	62.4	0.172	0.026	0.18	-0.04
21	IARIVB101	2539.6	2502.2	997.8	-435.0	2538.8	2500.4	998.0	-435.05	63.1	63.1	0.253	-0.007	0.17	-0.01
21	IARIVB102	2686.4	2655.8	991.5	-432.1	2684.8	2654.6	992.5	-432.54	62.9	63.0	0.193	-0.026	0.51	-0.15
21	IARIVB165	2499.5	2427.9	1003.7	-437.5	2499.9	2428.9	1004.0	-437.62	63.9	63.9	0.286	0.099	0.15	0.00
21	LZ347	**3040.3**	**3087.9**	981.7	-425.0	**3046.3**	**3093.9**	983.8	**-425.92**	**59.8**	**59.8**	0.370	0.149	0.16	0.00
21	SWRI17	2772.4	2787.0	957.3	-417.5					61.5	61.5	0.216	0.013	0.20	0.01
21	SWRI18	2787.4	2810.5	978.1	-426.3					62.9	62.9	0.314	-0.080	0.18	0.02
21	SWRI19	2749.4	2772.2	975.1	-425.2					62.6	62.6	0.337	-0.117	0.18	0.01
21	SWRI20	2813.0	2842.8	974.4	-424.7					63.9	64.0	0.328	-0.073	0.17	0.01

Sections highlighted in yellow refer to instances in which observed operational differences correlate to average intake lifter area loss studentized residuals. Results in red refer to the difference(s) observed within each section.

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Summary Table of Possible Operational Differences Affecting Average Intake Lifter Area Loss (More Detail in Appendix B)

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Stage	Lab Stand	Average Oil Gallery Pressure	Average Oil Gallery Pressure Median	Average Oil Gallery Pressure Std Dev	Average Oil Gallery Pressure Slope	Average Intake Manifold Pressure	Average Engine Power Std Dev	Average Engine Torque	Average Engine Torque Median	Average Exhaust Gas Temp Std Dev	Average Exhaust Gas Temp Slope	Average Fuel Flow Rate	Average Fuel Flow Rate Slope
1	IARIVB100	123.8	123.6	7.2	-0.32	36.7	0.03	24.6	24.6	6.7	-3.3	0.67	0.06
1	IARIVB101	113.9	114.4	8.6	0.57	38.4	0.04	25.0	25.0	6.3	-3.0	0.70	0.05
1	IARIVB102	128.6	128.5	8.7	-0.96	38.1	0.01	25.0	24.9	7.1	-3.4	0.60	0.06
1	IARIVB165	128.2	128.2	4.2	1.21	38.3	0.07	25.0	25.0	9.5	-4.6	0.66	0.05
1	LZ347	134.3	122.6	**23.1**	**-9.53**	**31.2**	**0.29**	**24.1**	**24.4**	**9.2**	**-4.4**	0.64	0.06
1	SWRI17	117.4	117.7	3.5	0.05	36.6	0.09	25.0	25.0	**10.7**	**-5.2**	0.66	0.07
1	SWRI18	121.9	121.1	4.3	-0.59	35.6	0.09	24.9	25.0	6.3	-3.1	0.70	0.05
1	SWRI19	125.5	125.3	3.0	-0.20	36.3	0.27	25.0	25.1	6.5	-3.2	0.69	0.06
1	SWRI20	121.4	120.9	4.7	-0.57	35.8	0.13	25.0	25.0	6.8	-3.3	0.72	0.06
12	IARIVB100	253.7	292.9	74.2	29.57	69.9	0.04	25.4	25.4	11.8	4.9	3.59	0.80
12	IARIVB101	250.7	281.0	66.4	25.40	72.0	1.03	25.1	25.1	13.4	5.7	3.81	0.79
12	IARIVB102	252.7	286.4	69.6	27.36	70.9	0.01	25.1	25.1	11.9	5.0	3.51	0.79
12	IARIVB165	264.0	290.2	60.6	22.81	68.9	2.72	25.2	25.1	3.9	0.8	3.03	0.30
12	LZ347	**197.0**	**174.1**	74.2	30.91	63.8	3.40	**26.5**	**26.4**	9.5	2.9	3.04	0.91
12	SWRI17	240.1	274.6	68.4	27.96	64.3	2.59	25.2	25.2	5.1	1.4	3.74	0.81
12	SWRI18	251.2	287.2	75.5	31.02	61.9	2.57	25.2	25.1	6.5	2.2	3.37	0.74
12	SWRI19	255.3	292.9	74.8	30.52	64.4	3.14	25.2	24.8	7.9	3.0	3.72	0.81
12	SWRI20	245.5	280.9	72.6	29.83	62.1	2.61	25.2	25.2	7.6	2.8	3.54	0.79
2	IARIVB100	322.8	324.1	8.3	-0.52	43.5	0.01	25.2	25.2	10.3	5.1	5.19	-0.40
2	IARIVB101	305.8	308.0	12.0	-0.42	44.7	0.02	25.0	25.0	9.2	4.5	5.19	-0.34
2	IARIVB102	316.7	319.7	8.6	-0.49	44.0	0.02	25.0	25.0	9.8	4.8	5.22	-0.42
2	IARIVB165	314.4	312.8	11.3	-0.18	43.0	0.10	25.0	25.0	11.6	5.6	**3.56**	**0.13**
2	LZ347	312.3	312.5	1.4	0.05	47.5	0.40	25.1	25.1	**13.4**	**6.5**	5.19	-0.38
2	SWRI17	306.3	306.0	1.7	-0.76	44.3	0.17	25.0	25.0	**14.8**	**7.4**	5.11	-0.39
2	SWRI18	327.0	326.9	1.3	-0.54	44.6	0.14	25.0	25.0	10.4	5.2	5.00	-0.36
2	SWRI19	326.9	326.7	1.3	-0.50	42.2	1.82	25.0	24.5	9.1	4.5	4.96	-0.38
2	SWRI20	318.9	318.8	1.2	-0.50	44.2	0.16	25.0	25.0	9.8	4.8	4.97	-0.37
21	IARIVB100	272.1	295.7	53.9	-21.16	16.4	0.02	24.8	24.8	17.2	-7.4	1.46	-0.59
21	IARIVB101	253.2	278.0	56.3	-21.89	17.5	0.99	24.9	24.9	17.8	-7.7	1.57	-0.52
21	IARIVB102	274.5	292.1	45.8	-17.68	16.3	0.02	24.9	24.9	16.7	-7.1	1.43	-0.59
21	IARIVB165	260.4	284.4	55.3	-21.50	17.0	2.63	24.8	24.8	6.2	-1.8	1.26	-0.35
21	LZ347	291.4	304.0	**27.2**	**-10.07**	21.5	2.95	**24.3**	24.4	14.5	-5.5	1.83	**-0.74**
21	SWRI17	266.2	288.1	45.7	-17.56	16.9	2.51	24.8	24.8	9.7	-3.5	1.42	-0.47
21	SWRI18	282.8	305.9	50.3	-19.39	19.2	2.57	24.8	24.8	11.6	-4.7	1.65	-0.50
21	SWRI19	282.6	305.4	50.5	-19.53	17.7	3.17	24.8	24.1	11.5	-4.7	1.44	-0.47
21	SWRI20	279.0	299.1	45.8	-17.50	19.3	2.55	24.9	24.9	11.3	-4.6	1.57	-0.47

Sections highlighted in yellow refer to instances in which observed operational differences correlate to average intake lifter area loss studentized residuals. Results in red refer to the difference(s) observed within each section.

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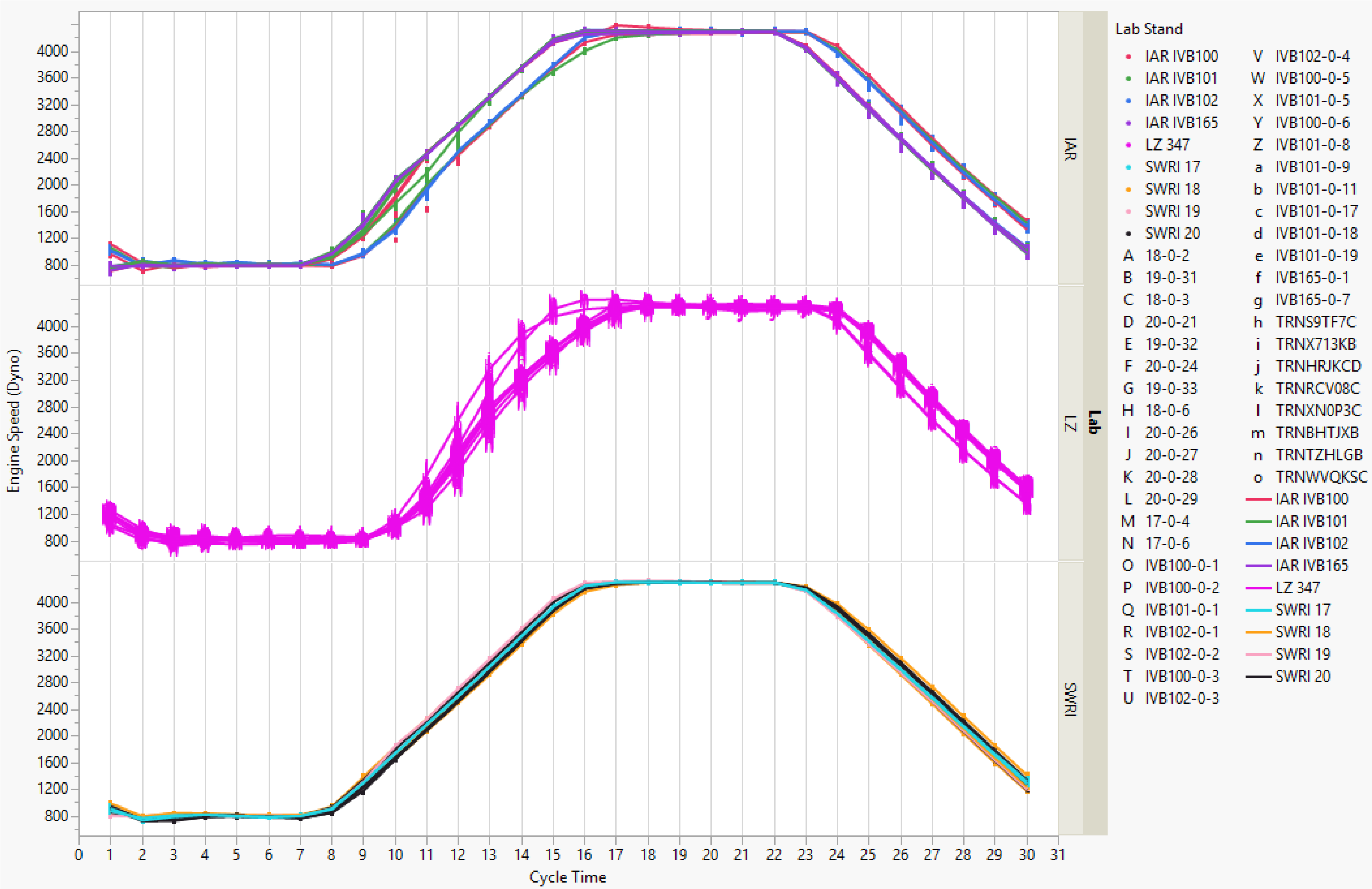
Summary Table of Other Possible Operational Differences Affecting Average Intake Lifter Area Loss (More Detail in Appendix B)

Stage	Lab Stand	Average Air Fuel Ratio Std Dev	Average Fuel Rail Temp Std Dev	Average Rocker Cover Coolant In Temp Std Dev	Average Rocker Cover Coolant Out Temp Std Dev	Average Crankcase Gas Pressure Std Dev
1	IARIVB100	0.77	0.35	0.22	0.25	0.536
1	IARIVB101	0.99	0.14	0.23	0.22	0.534
1	IARIVB102	0.78	0.05	0.32	0.32	0.468
1	IARIVB165	1.06	0.35	0.45	0.45	0.565
1	LZ347	0.43	0.07	**0.03**	**0.03**	**0.091**
1	SWRI17	1.21	0.17	0.34	0.34	**0.096**
1	SWRI18	1.92	0.39	0.32	0.33	**0.049**
1	SWRI19	2.00	0.27	0.14	0.13	**0.097**
1	SWRI20	2.08	0.30	0.20	0.19	**0.188**
12	IARIVB100	1.17	0.35	0.22	0.25	0.993
12	IARIVB101	1.10	0.14	0.23	0.22	1.300
12	IARIVB102	0.95	0.06	0.33	0.33	1.020
12	IARIVB165	0.93	0.28	0.46	0.46	1.412
12	LZ347	0.37	0.07	**0.03**	**0.03**	**0.239**
12	SWRI17	0.57	0.18	0.34	0.34	**0.090**
12	SWRI18	0.64	0.40	0.33	0.33	**0.153**
12	SWRI19	0.56	0.28	0.16	0.15	**0.144**
12	SWRI20	0.62	0.31	0.21	0.20	**0.172**
2	IARIVB100	0.28	0.36	0.22	0.25	0.838
2	IARIVB101	0.29	0.15	0.24	0.23	0.939
2	IARIVB102	0.26	**0.06**	0.33	0.33	0.774
2	IARIVB165	0.28	0.41	0.44	0.44	0.996
2	LZ347	**0.14**	**0.06**	**0.03**	**0.03**	**0.142**
2	SWRI17	0.23	0.16	0.34	0.34	**0.059**
2	SWRI18	0.20	0.39	0.32	0.34	**0.069**
2	SWRI19	0.25	0.28	0.15	0.14	**0.106**
2	SWRI20	0.25	0.29	0.19	0.19	**0.143**
21	IARIVB100	3.17	0.36	0.22	0.25	1.004
21	IARIVB101	2.25	0.14	0.23	0.23	1.362
21	IARIVB102	3.09	**0.06**	0.33	0.33	1.069
21	IARIVB165	2.28	0.45	0.43	0.43	1.473
21	LZ347	3.93	**0.07**	**0.03**	**0.03**	**0.091**
21	SWRI17	1.37	0.17	0.33	0.34	**0.053**
21	SWRI18	1.99	0.39	0.33	0.33	**0.071**
21	SWRI19	2.23	0.28	0.14	0.14	**0.086**
21	SWRI20	2.44	0.30	0.20	0.19	**0.192**

Sections highlighted in yellow refer to instances in which observed operational differences correlate to average intake lifter area loss studentized residuals. Results in red refer to the difference(s) observed within each section.

Possible Operational Differences Affecting Average Intake Lifter Area Loss

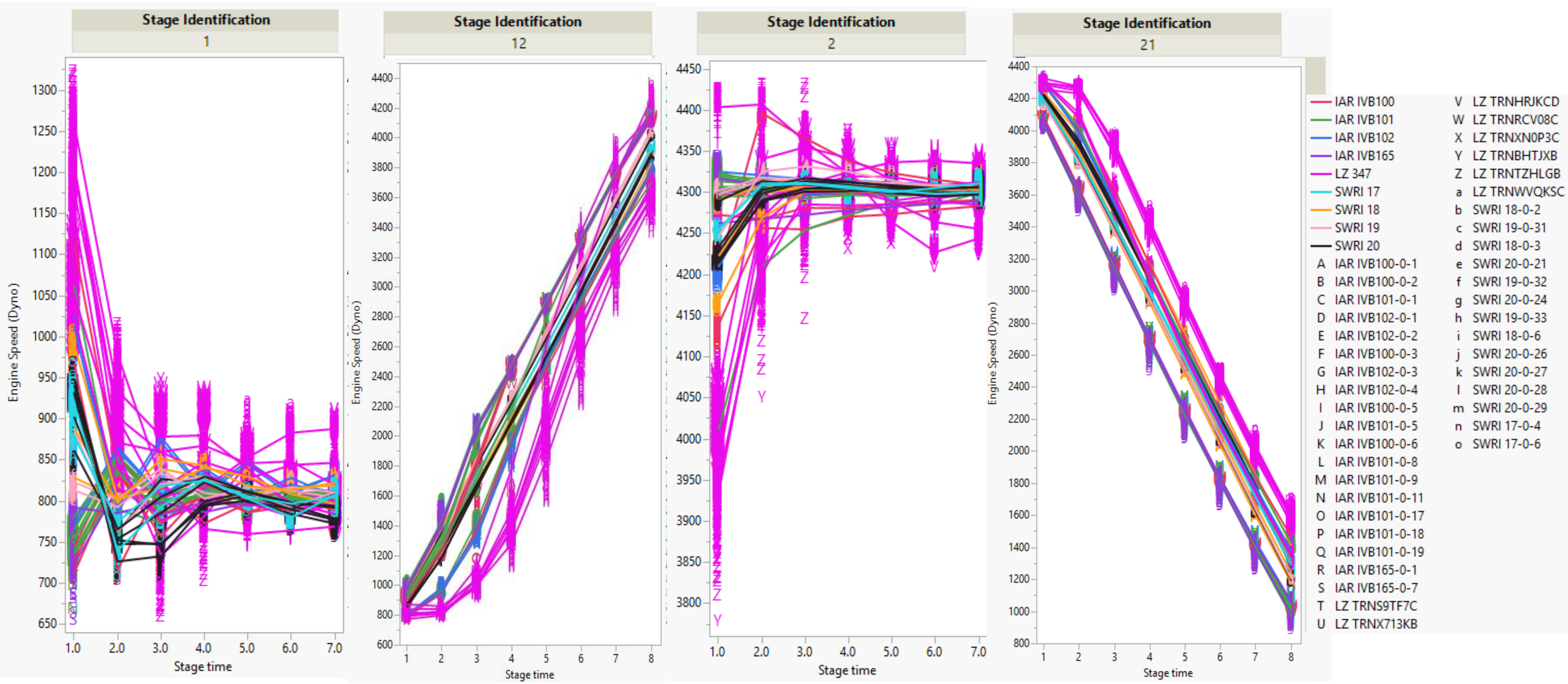
SUCCESS TOGETHER



There appears to be an offset in the engine speed (Dyno) cycles among the labs;
LZ generally 1 to 2 seconds behind SwRI; some early IAR tests one second behind SwRI.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

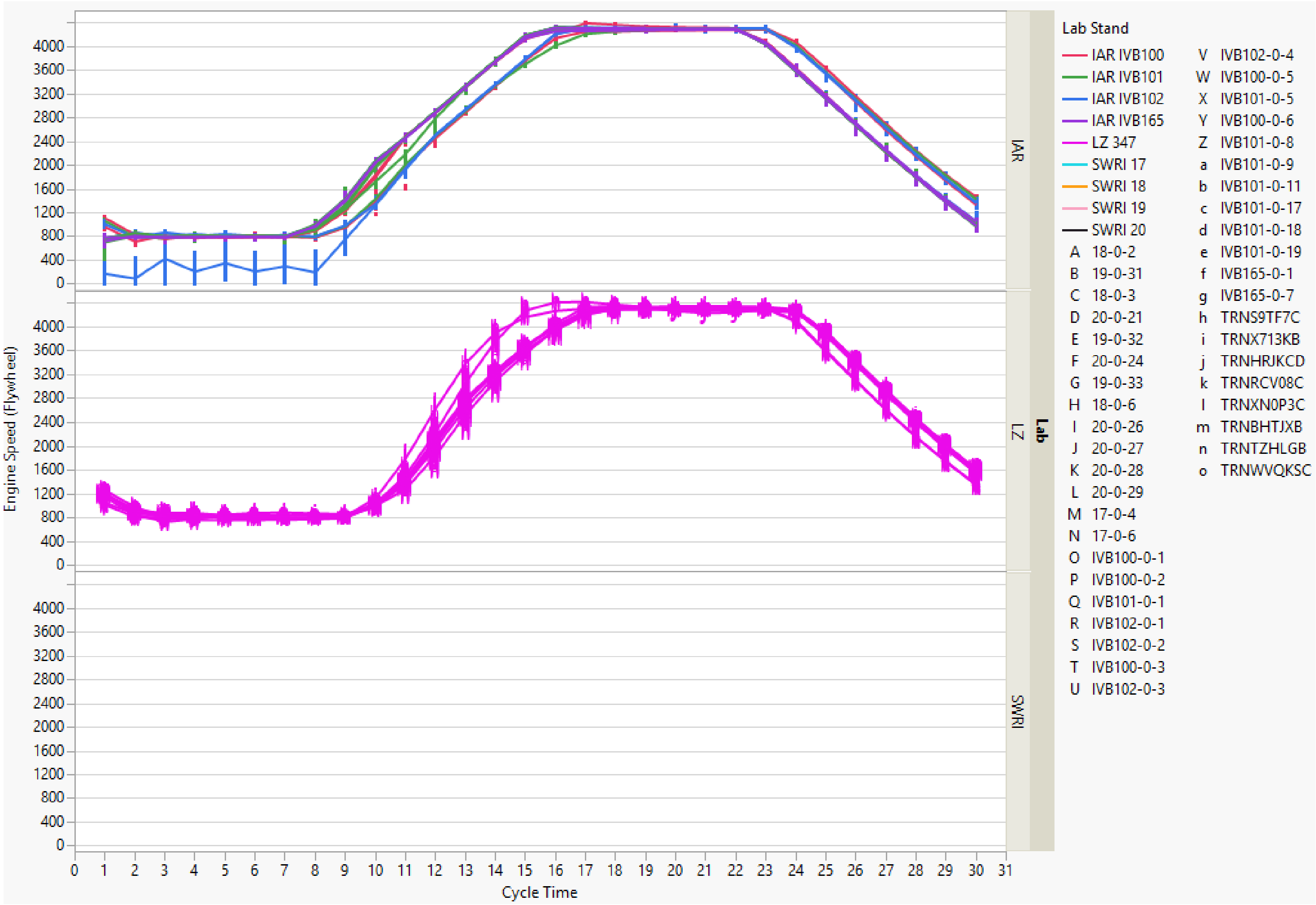


Analyses suggest differences in engine speed may affect test severity. In particular, LZ has:

- Highest average engine speed in stages 1, and 21
- Lowest average engine speed in stage 12
- Highest within test cycle variability in stage 2
- Much different slopes in stages 1 and 2; stage 12 slope is steeper as well

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

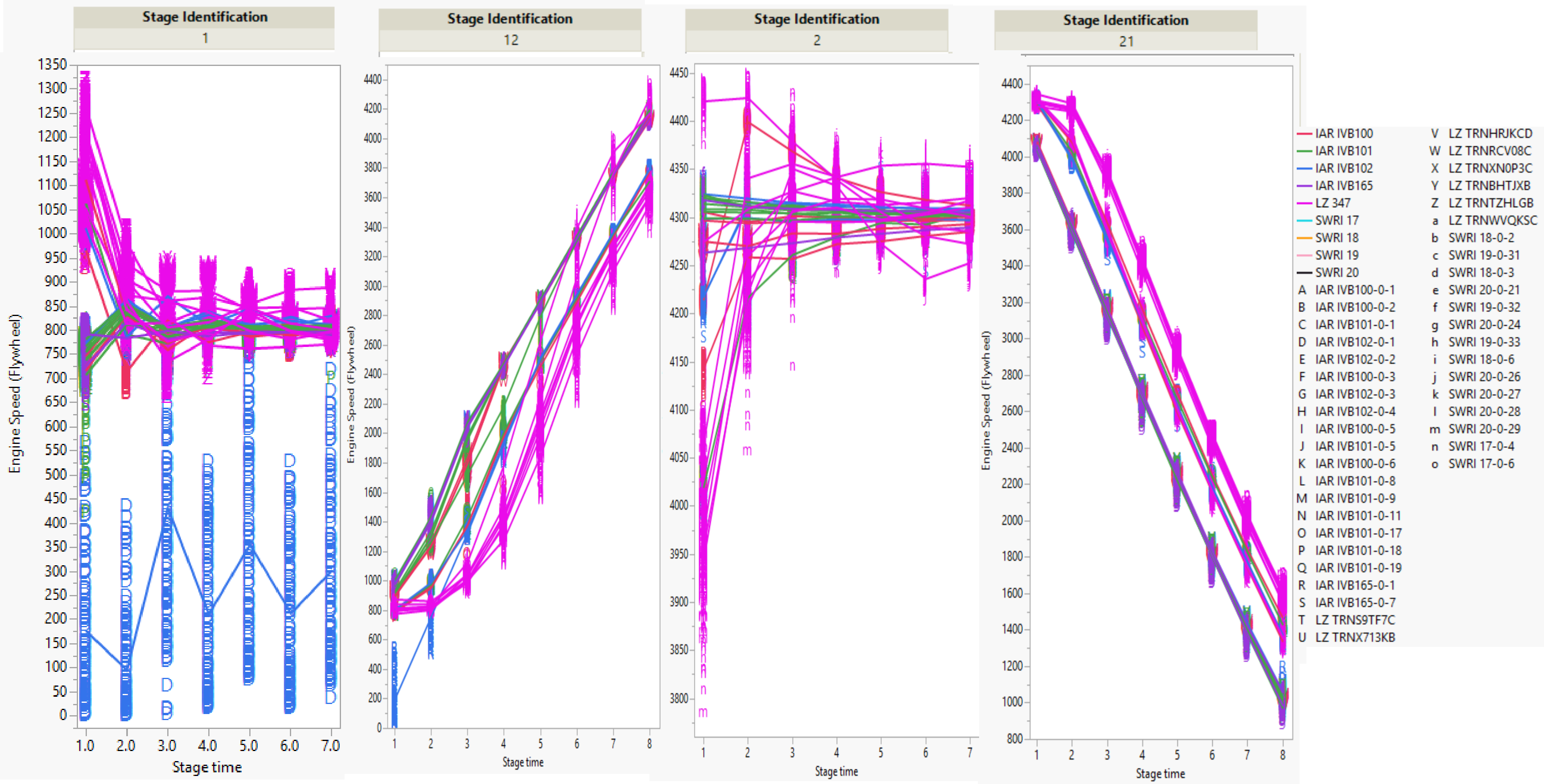


There appears to be an offset in the engine speed (flywheel) cycle among the labs; some early IAR tests one second behind others.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

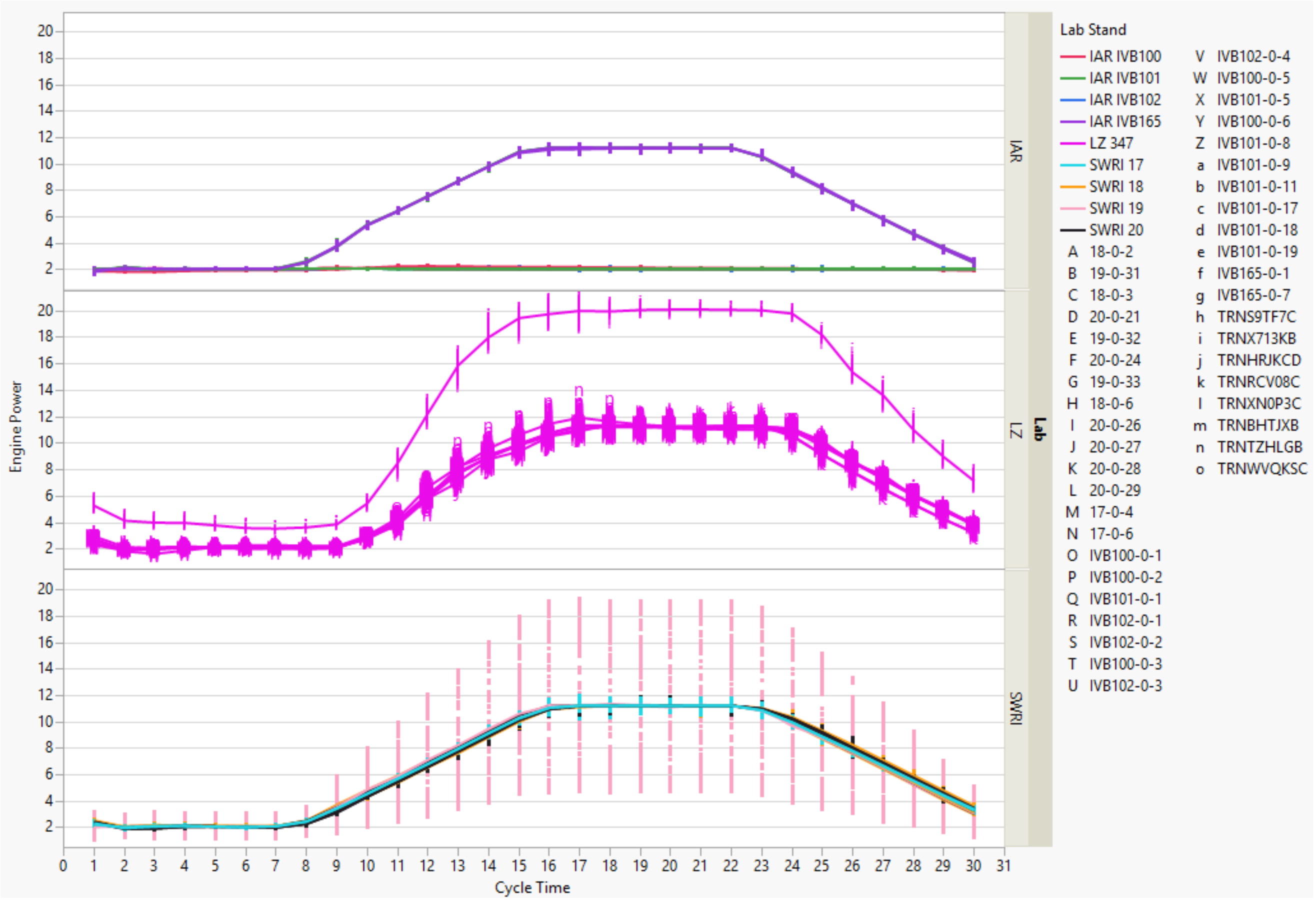


Analyses suggest differences in engine speed may affect test severity. In particular, LZ has:

- Higher average engine speed in stages 21
- Lowest average engine speed in stage 12
- Highest within test cycle variability in stages 1 and 2
- Much different slopes in stages 1, 2, and 21

Possible Operational Differences Affecting Average Intake Lifter Area Loss

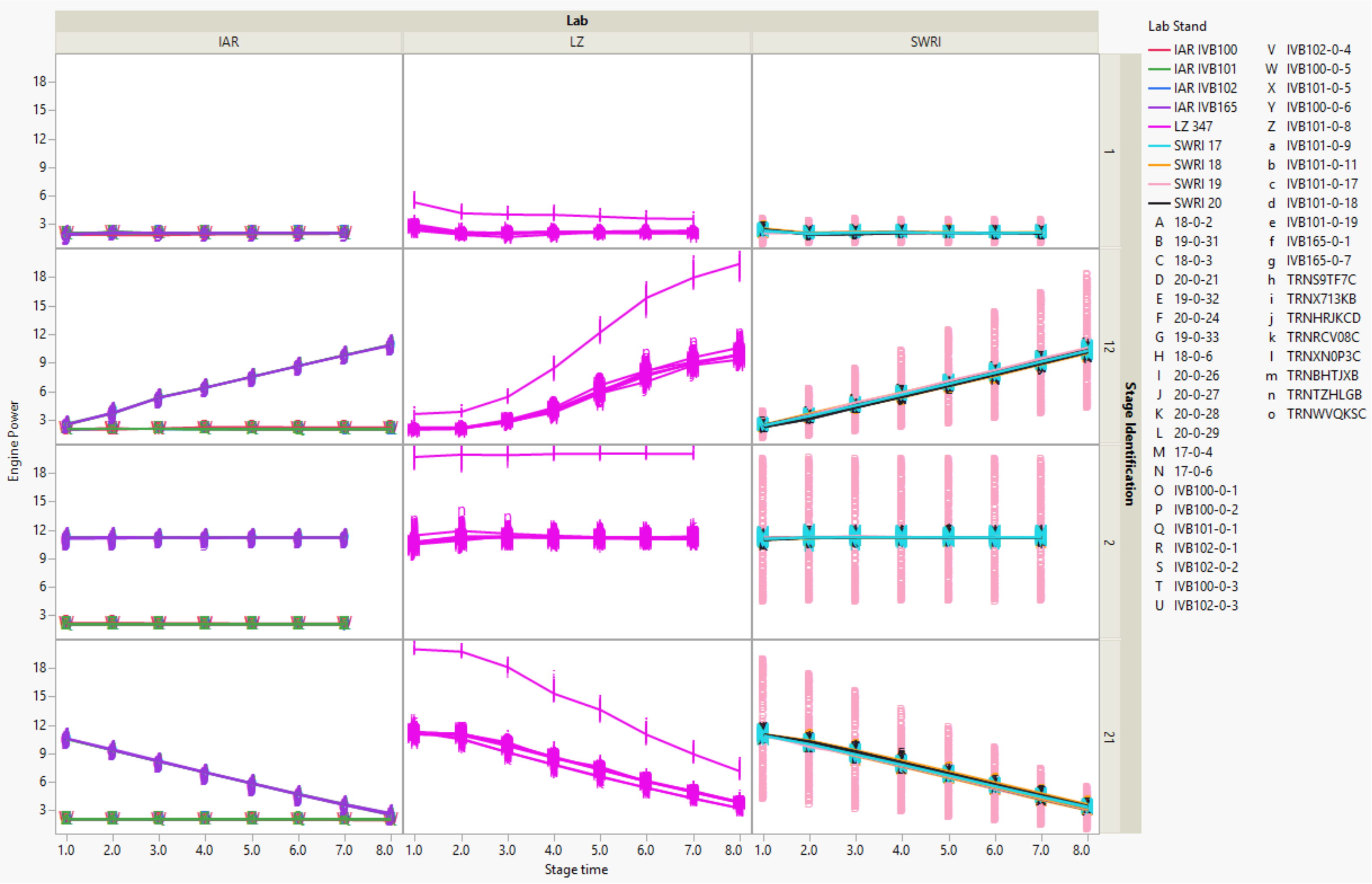
SUCCESS TOGETHER



- Compared to the other labs, there is a slower increase in engine power at LZ at the beginning of the transition from stage 1 to stage 2. Mid way through the transition the engine power ramps up at LZ and the engine power among the labs is similar by the beginning of stage 2.
- One LZ test has much higher engine power.
- The engine power of some IAR tests appears to be fairly constant across the stages.

Lubrizol

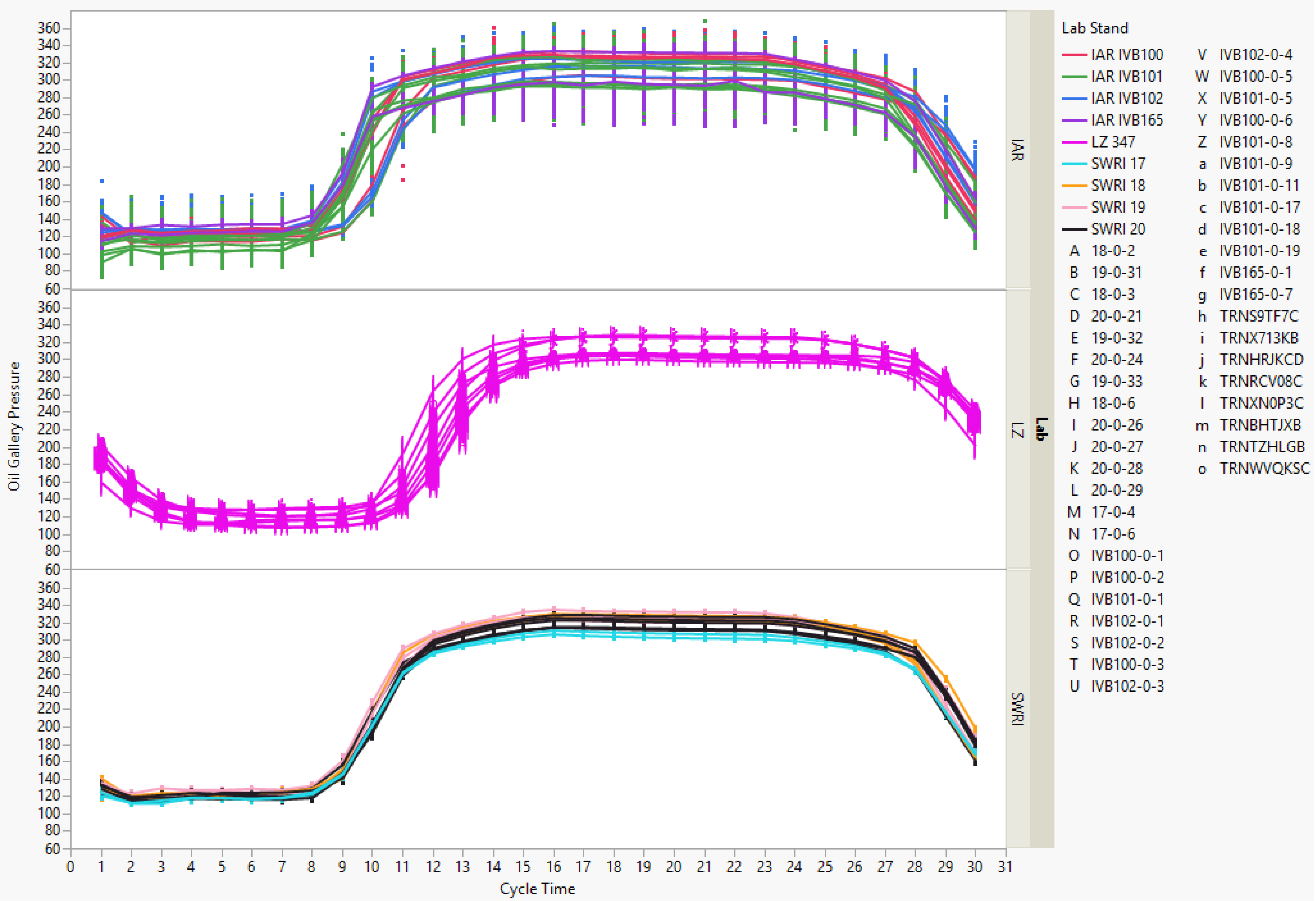
Possible Operational Differences Affecting Average Intake Lifter Area Loss



Analyses suggest differences in engine power may affect test severity.
In particular, LZ has higher within cycle variability in stage 1

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

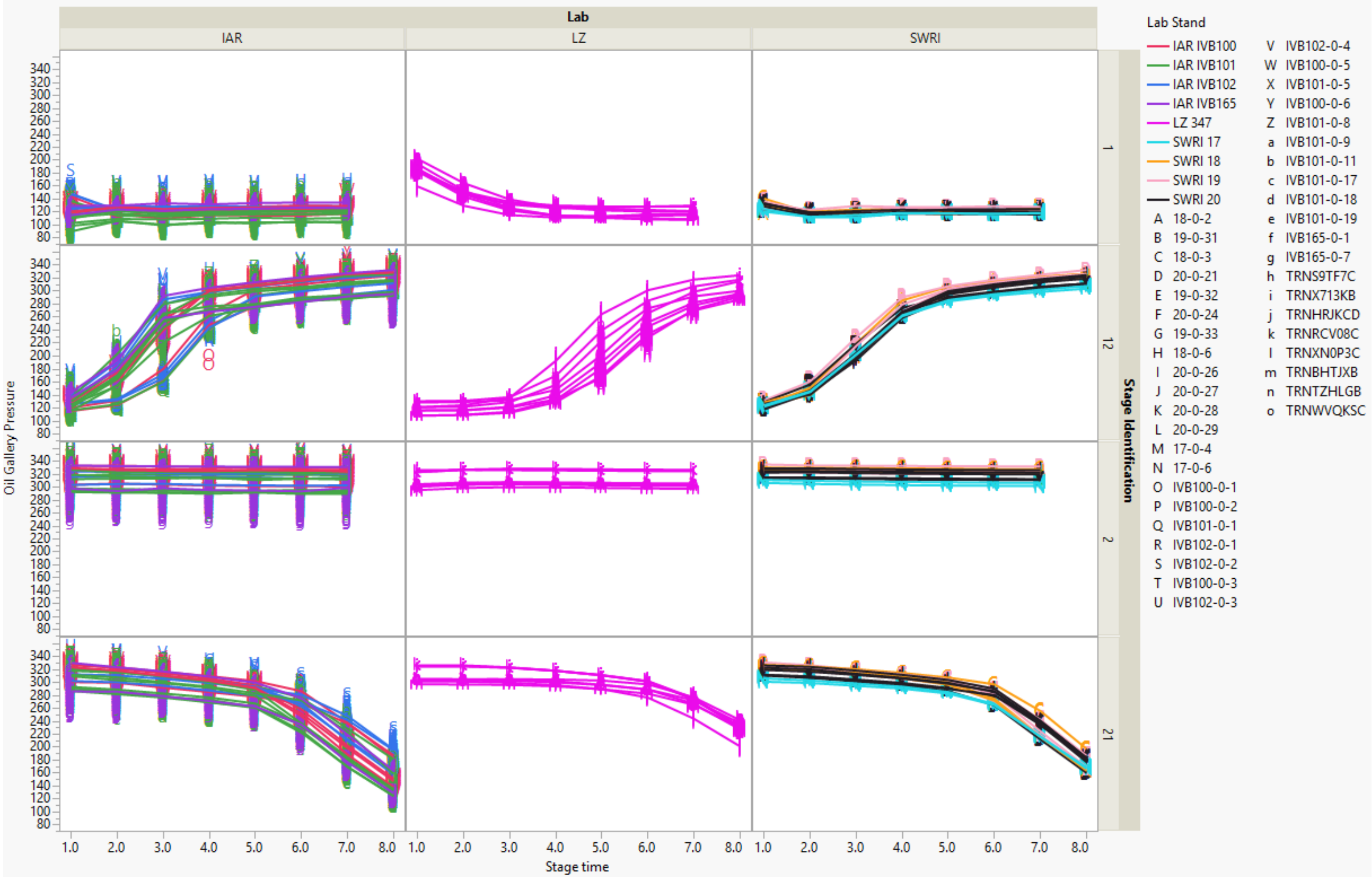


There appears to be an offset in the oil gallery pressure cycle among the labs;
LZ ~2 seconds behind SwRI; some early IAR tests are one second behind SwRI.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



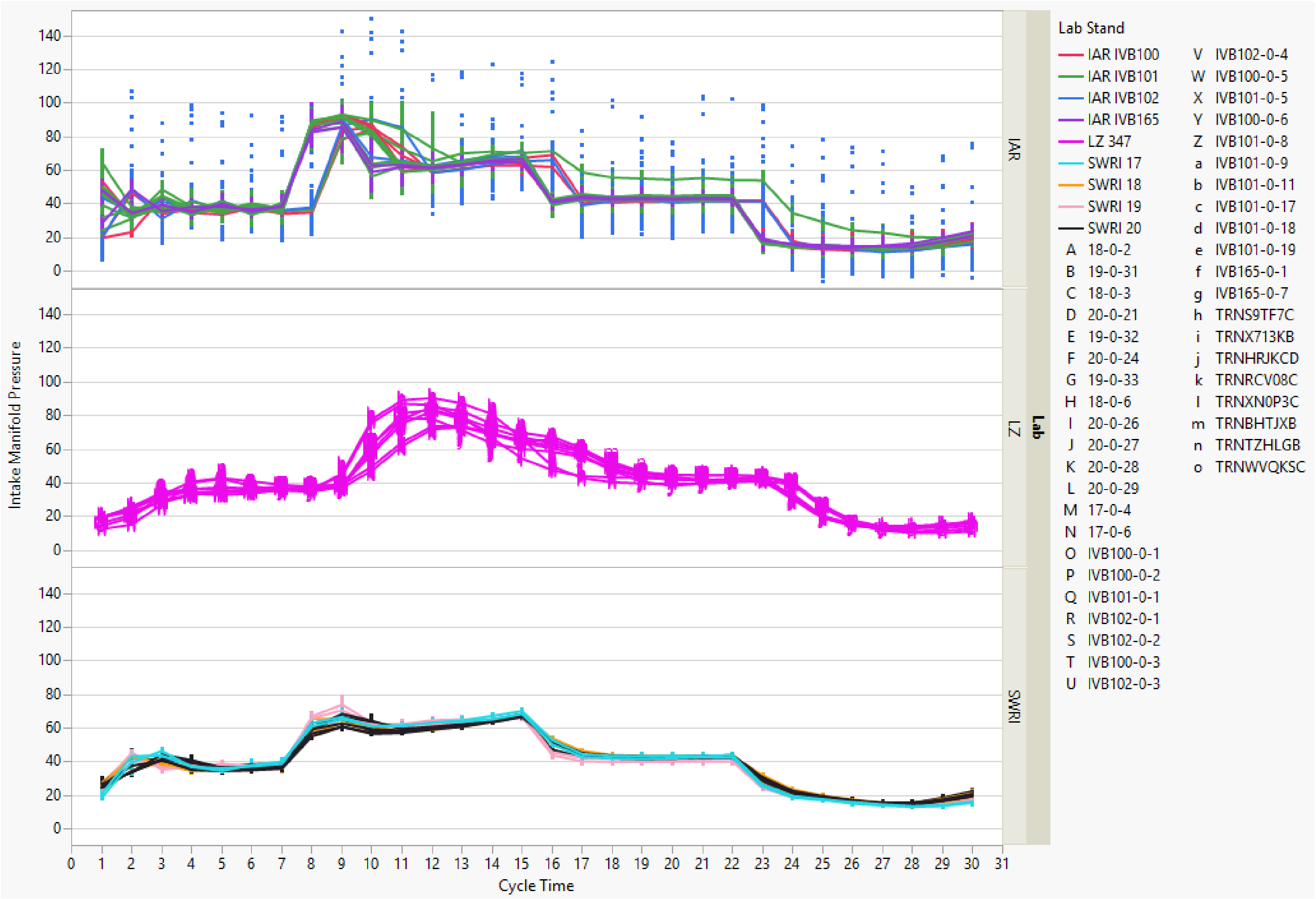
Analyses suggest differences in gallery pressure may affect test severity. In particular, LZ has:

- Lower stage 12 average pressure
- More within test cycle variability in stage 1; less in stage 21
- Steepest slope in stage 1; smallest slope in stage 21
- These differences are affected by the differences in pressure cycles among the labs (prior slide)

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

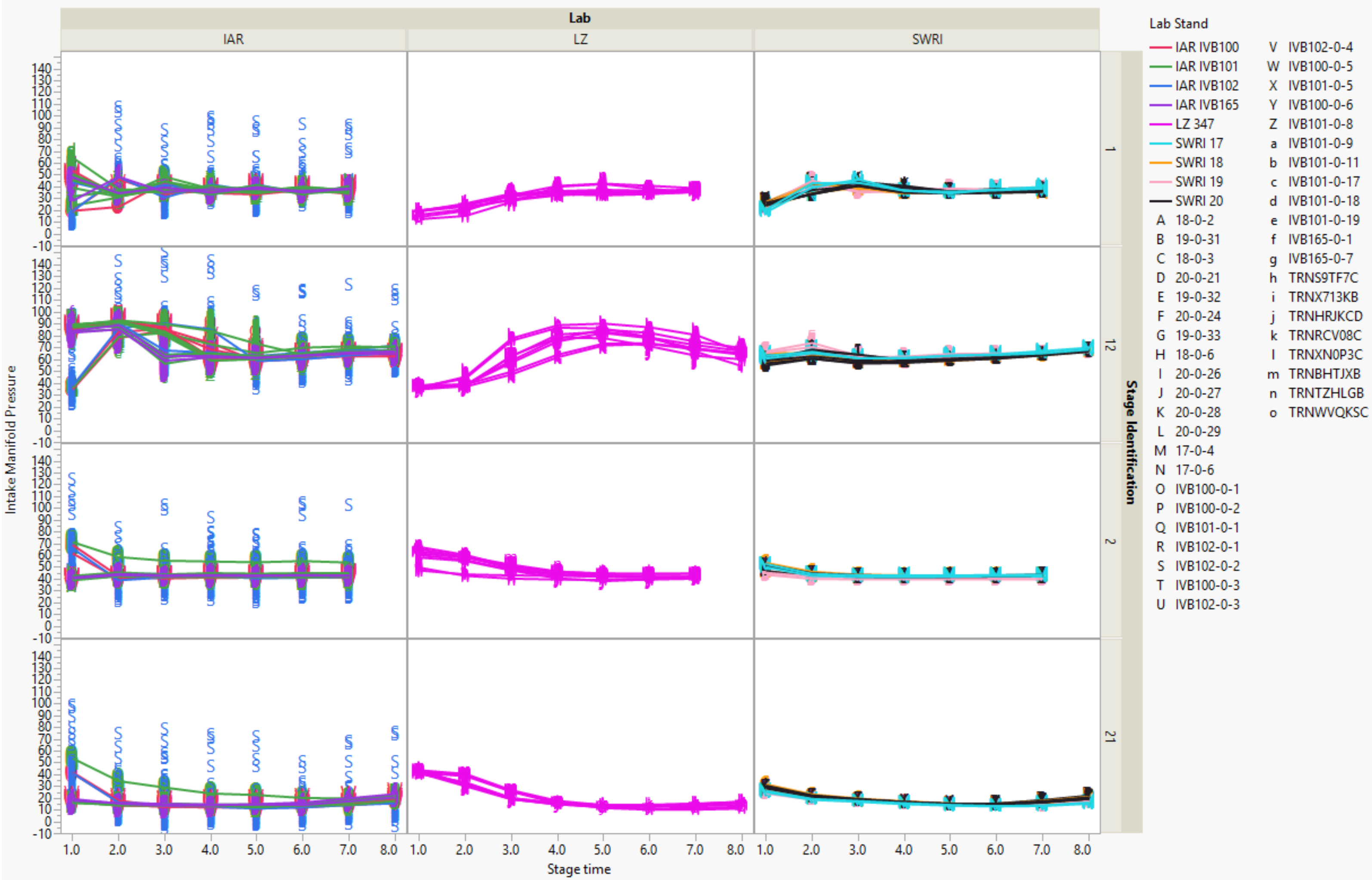
SUCCESS TOGETHER



- There appears to be a difference in how the intake manifold pressure cycles at LZ compared to the other labs; it is generally delayed by a second and the step changes in pressure are more gradual.
- Early IAR tests also track 1 second behind SwRI tests.

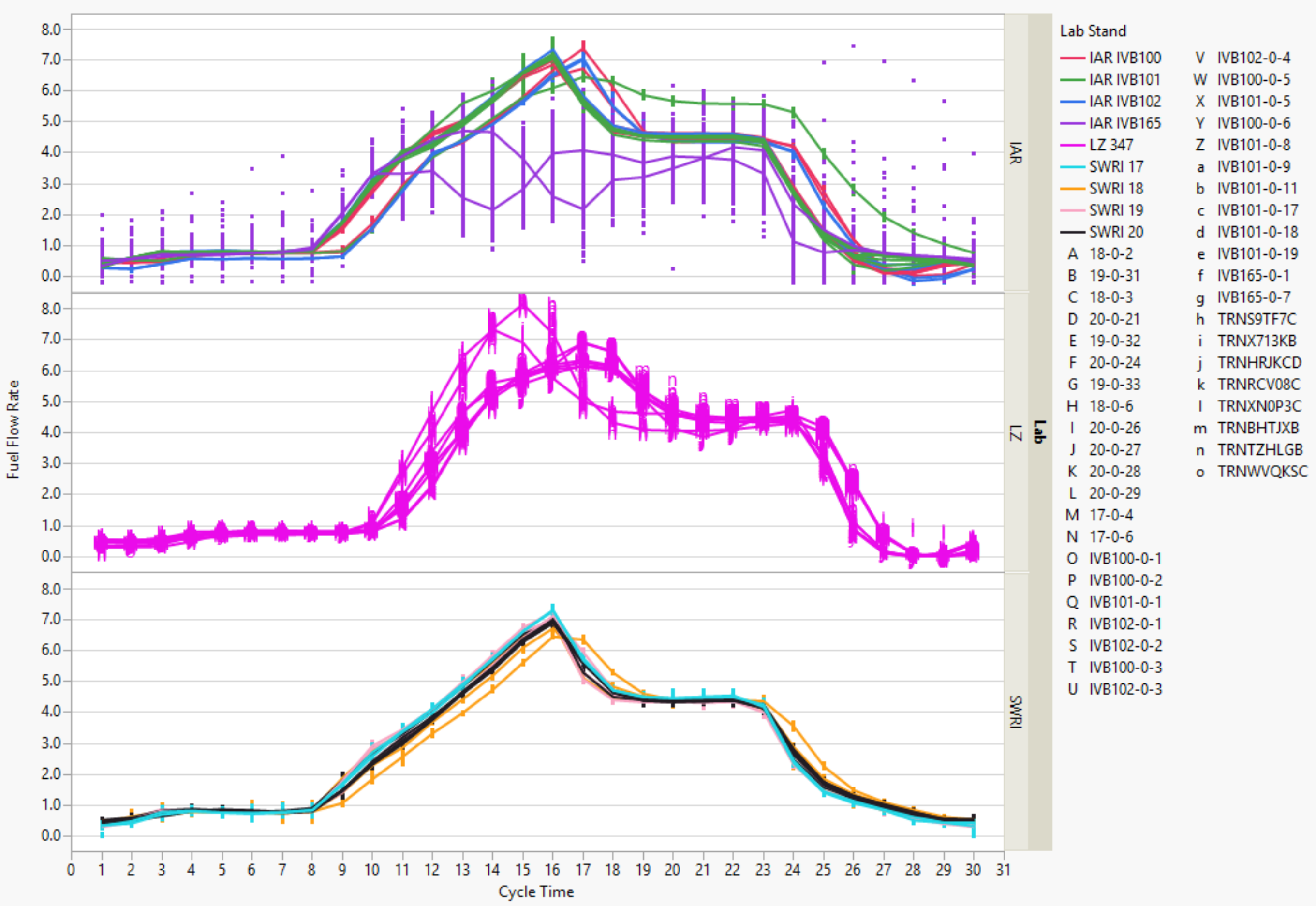
Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss



Analyses suggest differences in intake manifold pressure may affect test severity. In particular, LZ has lower stage 1 average pressure.

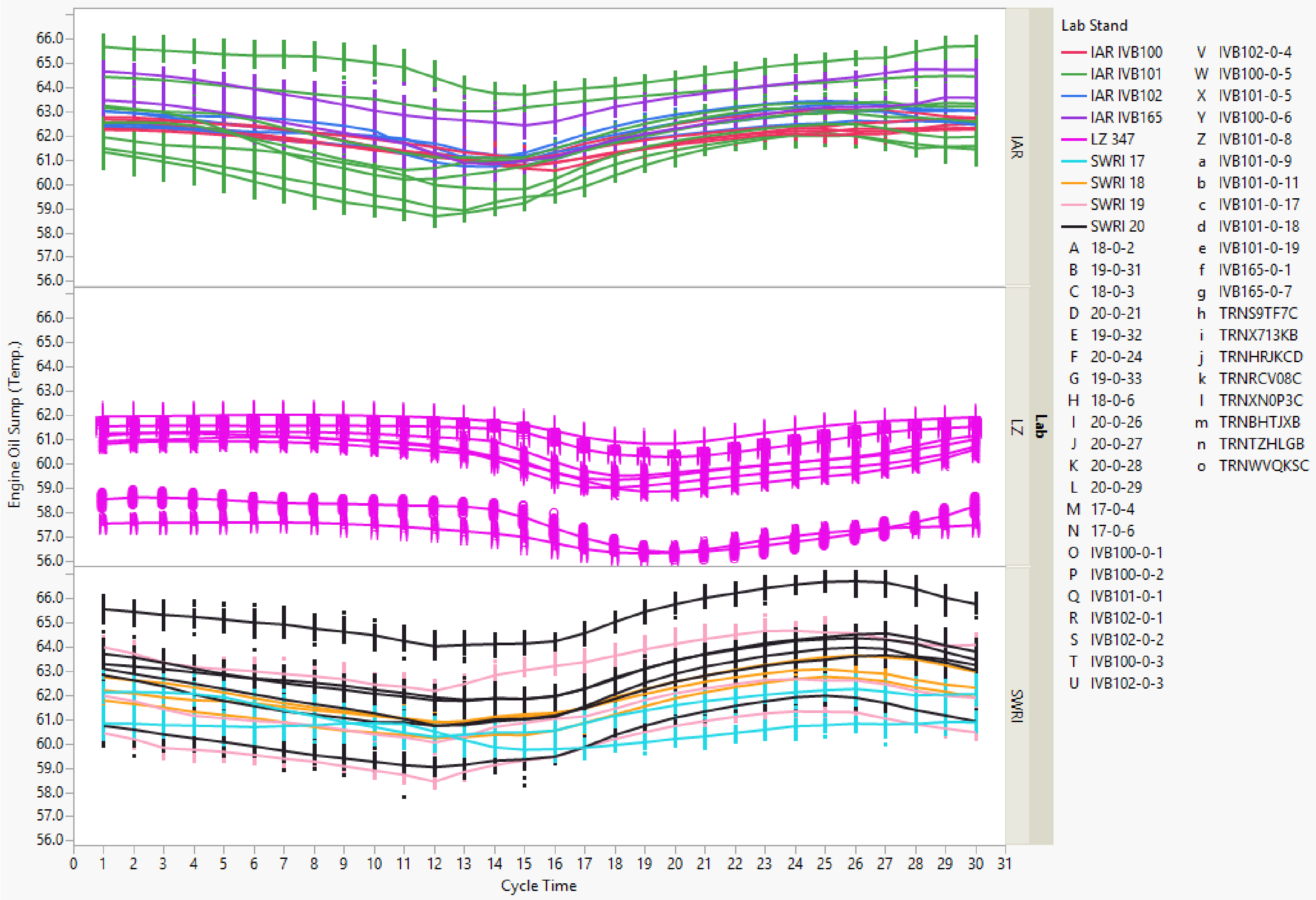
Possible Operational Differences Affecting Average Intake Lifter Area Loss



- The fuel flow rate of IAR165 does not ramp as high as all other stands in the transition from stage 1 to stage 2.
- A couple LZ tests have a steeper fuel flow rate in the transition from stage 1 to stage 2.
- LZ fuel flow rate changes are not as linear as the other labs.
- Most LZ tests and early IAR tests lag a second behind SwRI tests.

Possible Operational Differences Affecting Average Intake Lifter Area Loss

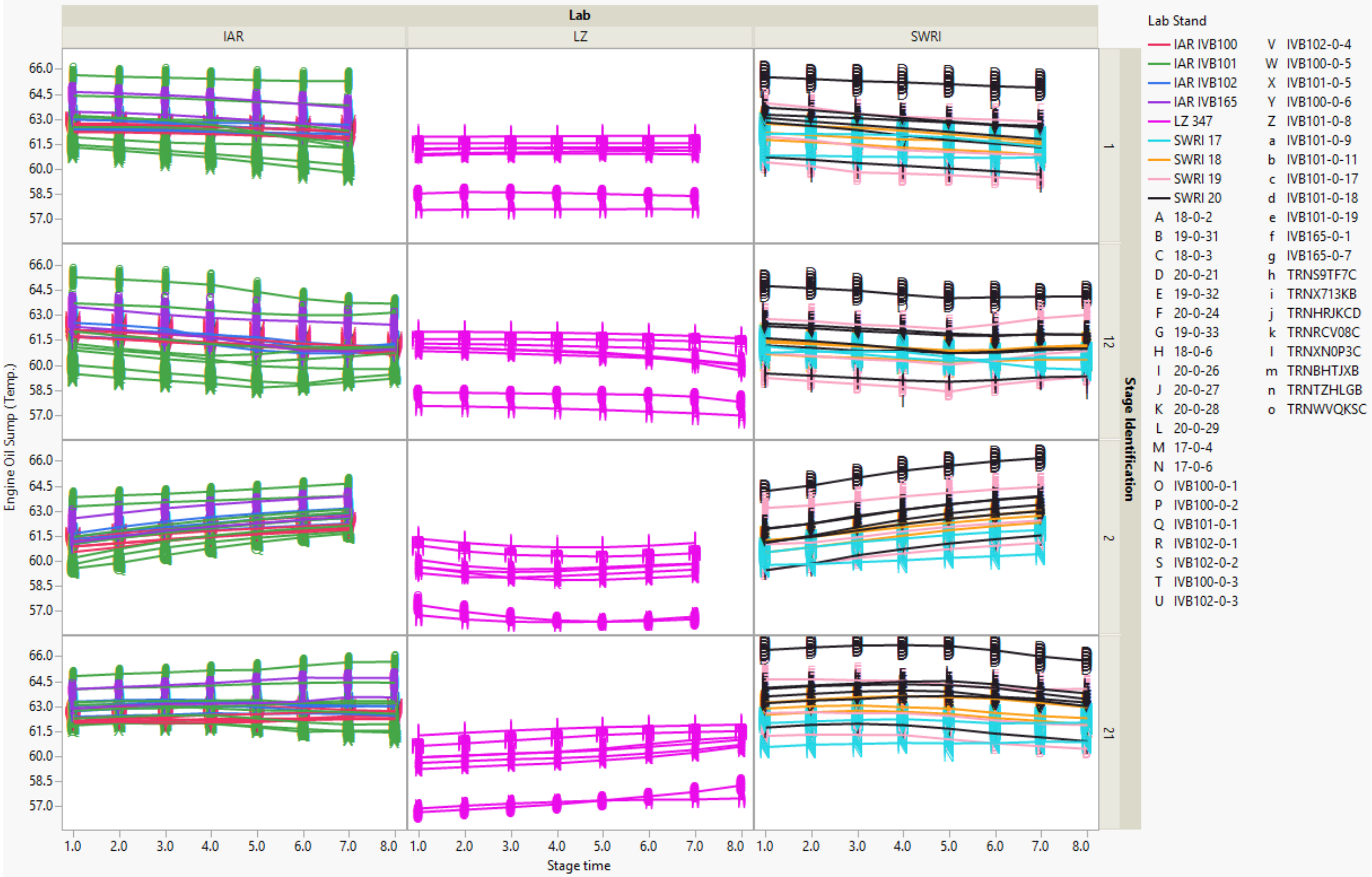
SUCCESS TOGETHER



The dip in oil sump temp occurs at a different time within the cycle at LZ than the other labs. At IAR and SwRI, this dip occurs at the end of the transition from stage 1 to stage 2. At LZ, the dip in sump temp occurs in stage 2.

Lubrizol

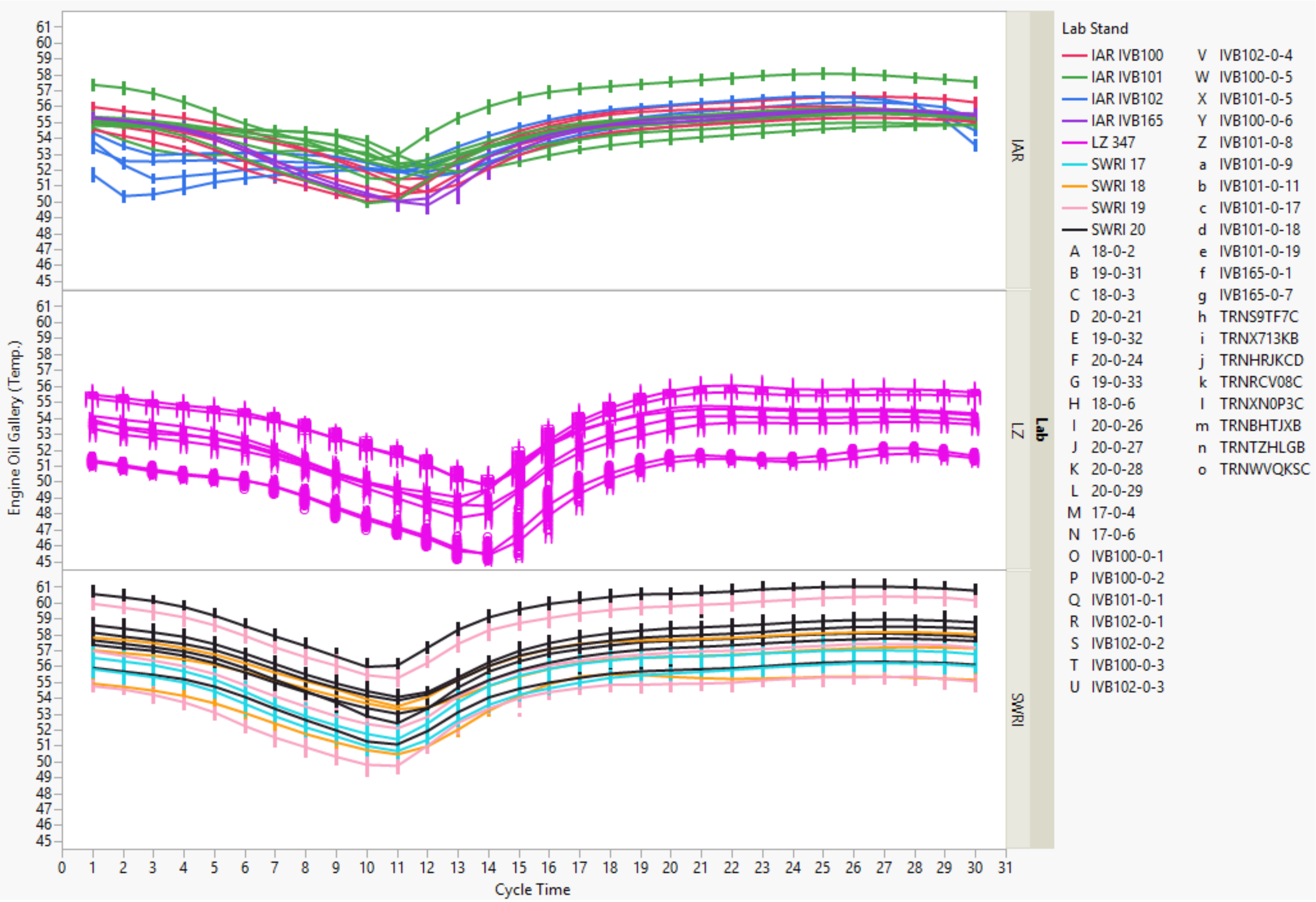
Possible Operational Differences Affecting Average Intake Lifter Area Loss



Analyses suggest differences in sump temp may affect test severity. In particular, LZ has:

- Lower average stage 2 and 21 oil sump temp
- Less within test cycle variability in stage 1 and 2
- Little change in oil sump temp throughout stages 1 and 2 whereas the other labs slightly decrease in stage 1 and increase in stage 2
  - These differences are affected by the sump temp dip differences across at the labs

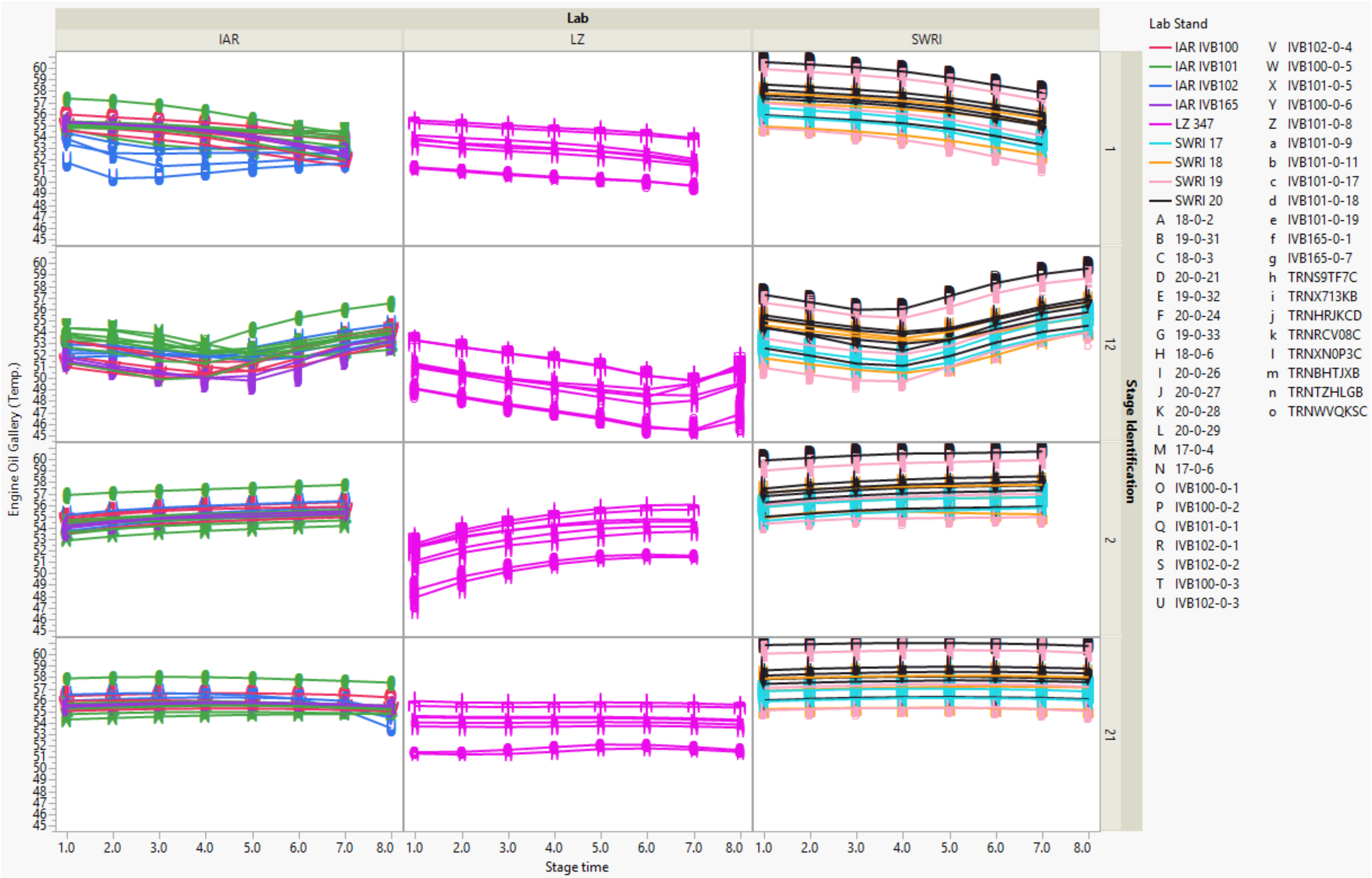
Possible Operational Differences Affecting Average Intake Lifter Area Loss



- The dip in oil gallery temp occurs at a different time at the labs.
- LZ dips at the end of the transition from stage 1 to stage 2. IAR and SwRI generally dip in the middle of the transition with IAR's dip generally occurring about 1 to 2 seconds after SwRI.
- The dip in oil gallery temperature is not consistent within IAR tests. Most notable are tests run on stand 102.

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



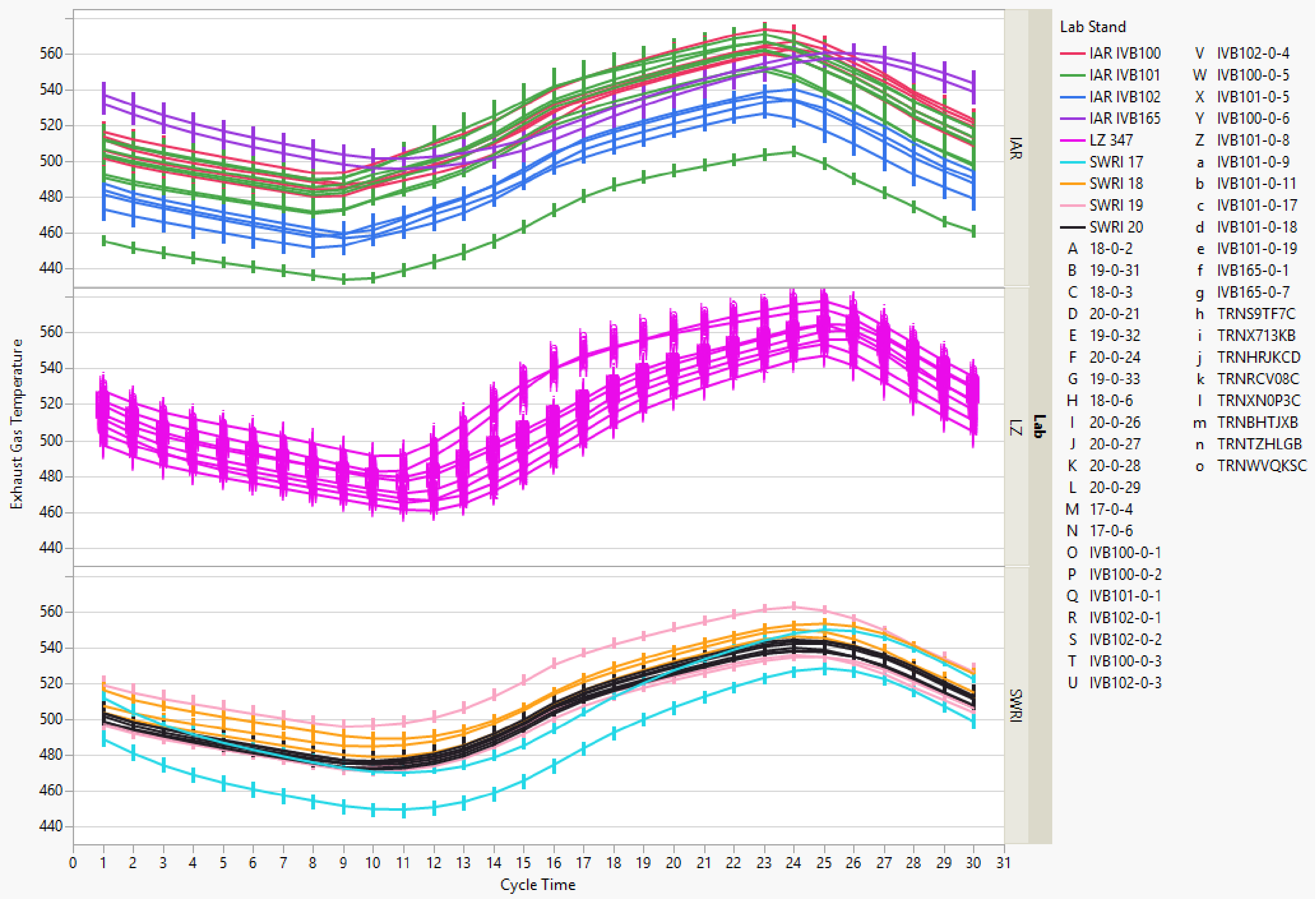
Analyses suggest differences in gallery temp may affect test severity. In particular, LZ has:

- More within test cycle variability in stage 2
- Differing slopes than other labs within stages 12 and 2
- These differences are affected by the inconsistency of when the gallery temp dips at the labs

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

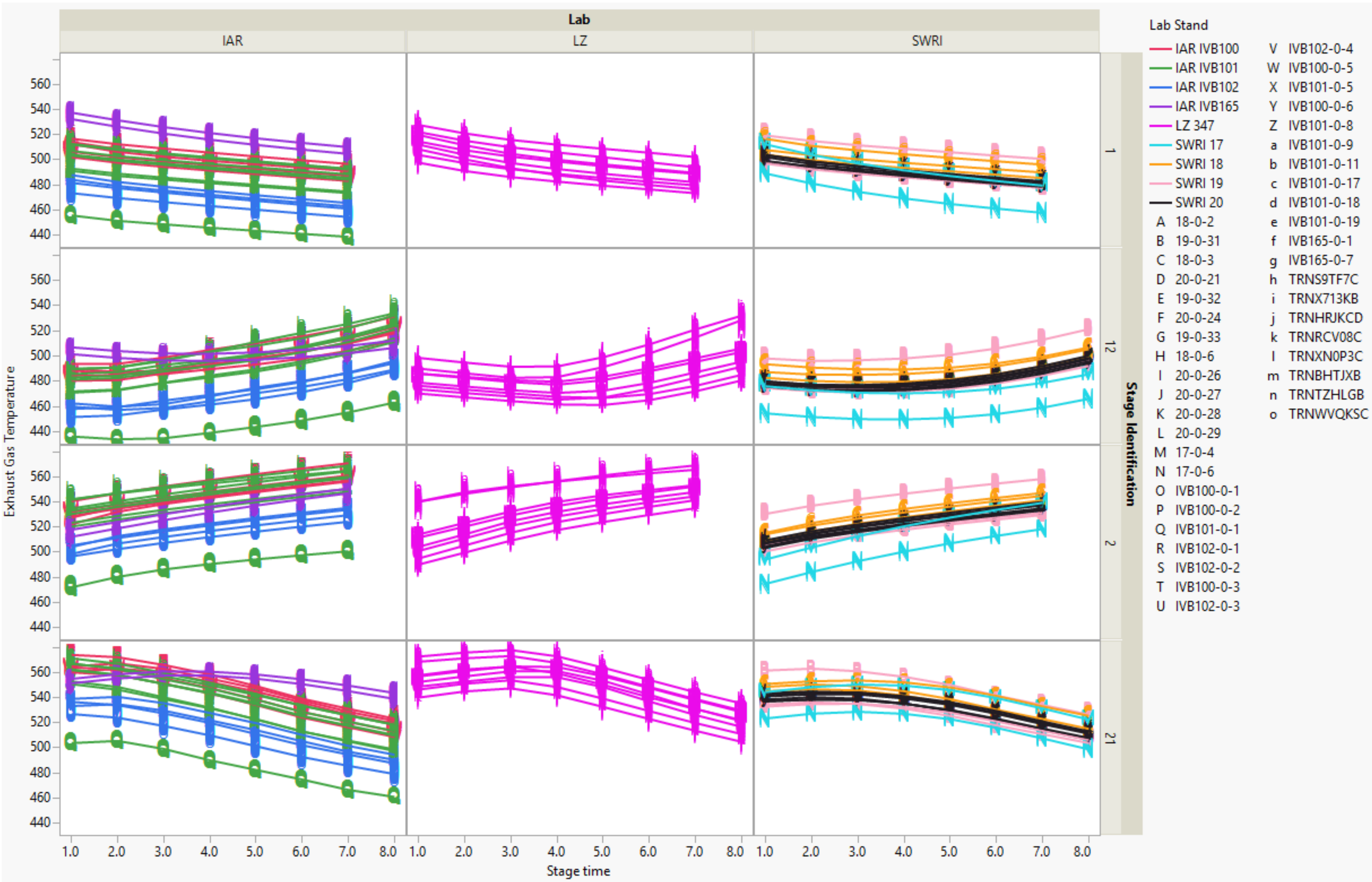


The dip in exhaust gas temp at IAR occurs ~3 seconds prior to LZ and SwRI (with the exception of stand 165 which tracks 1 or 2 seconds behind LZ and SwRI).

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



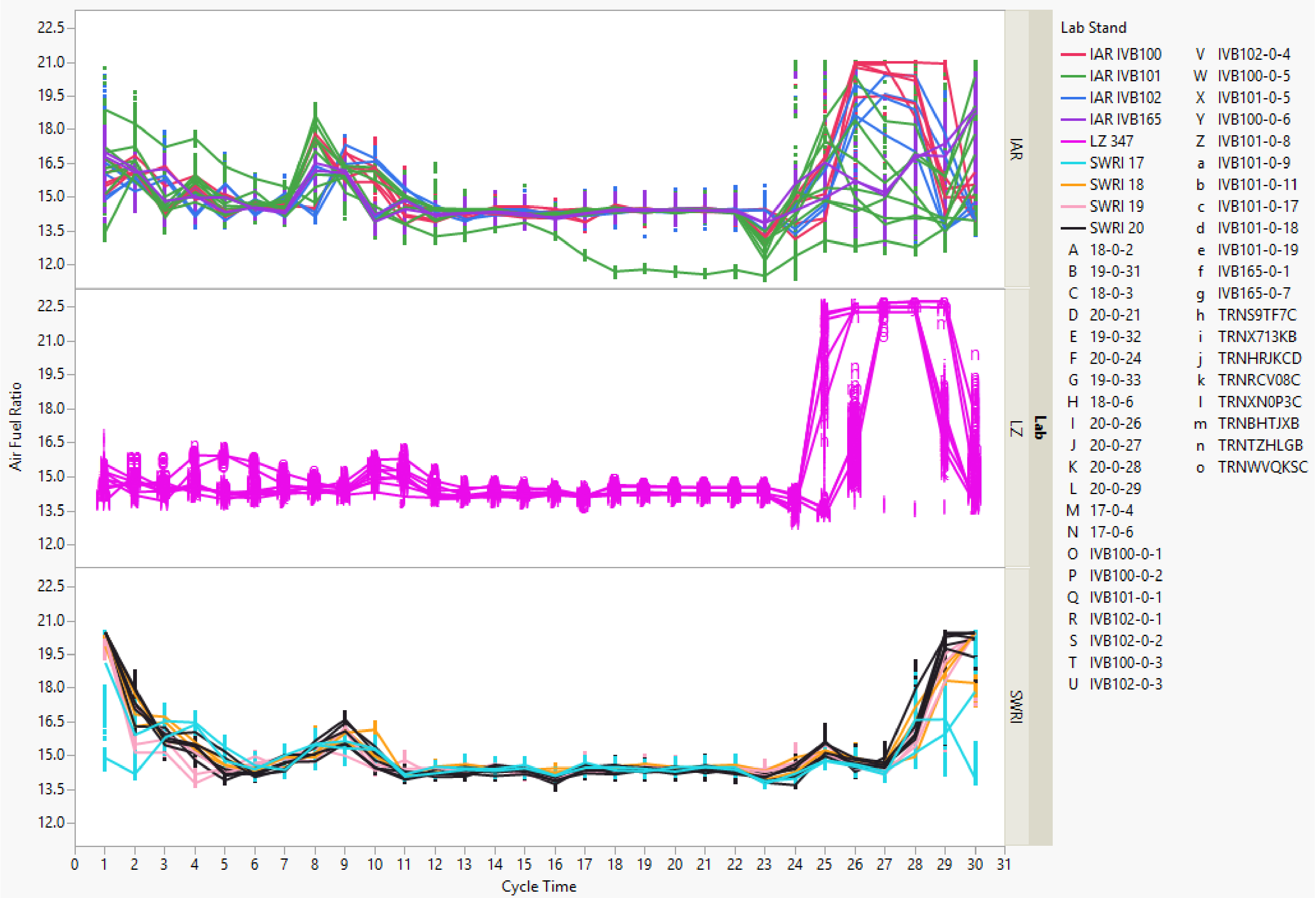
Analyses suggest differences in exhaust gas temp may affect test severity. In particular, LZ and SwRI17 have:

- Steep stage 1 and 2 slopes
- Most within cycle variability in stages 1 and 2

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

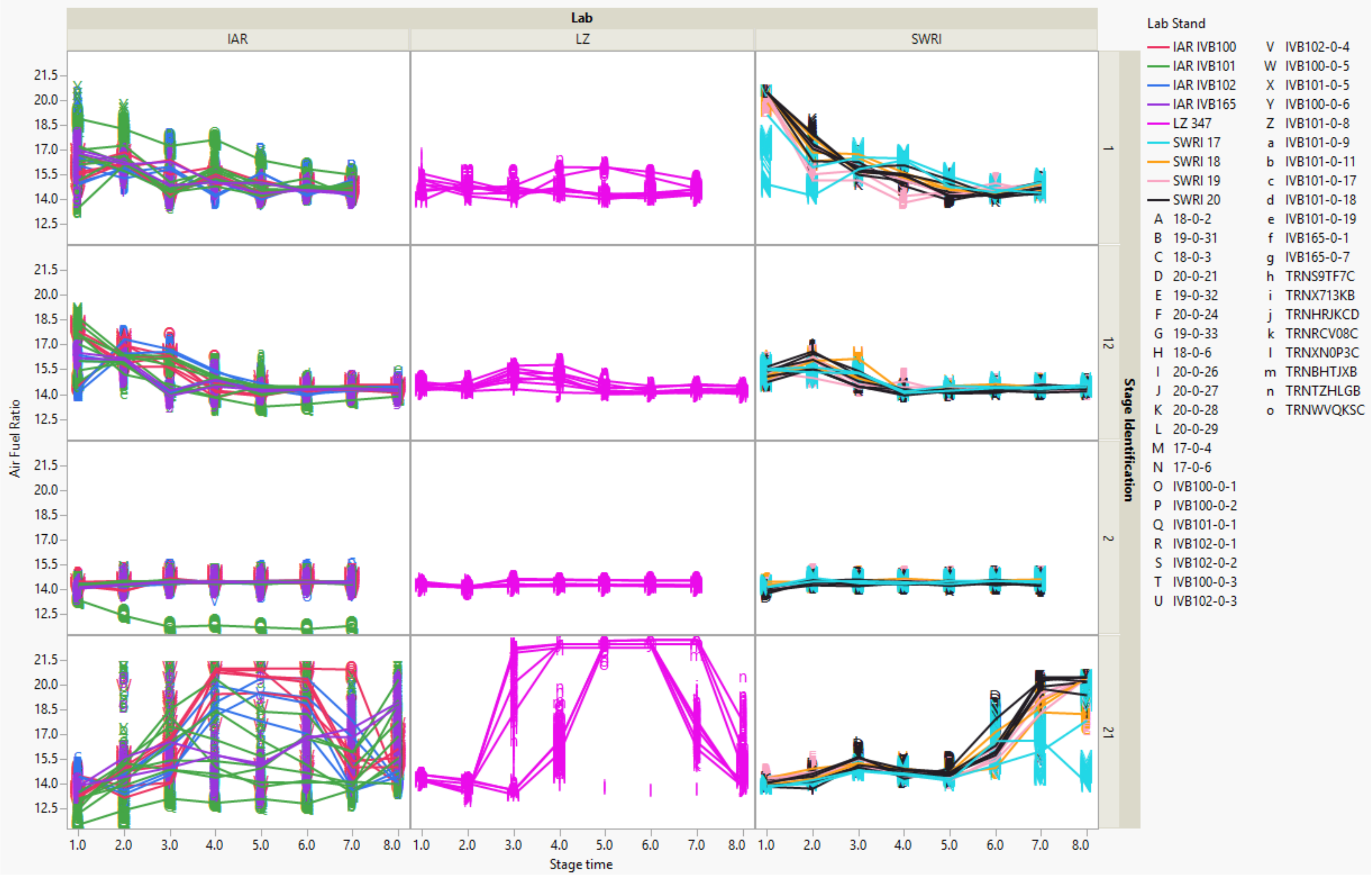


The air fuel ratio tracks differently at SwRI than the other labs in stage 1 and the transition from stage 2 to 1.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

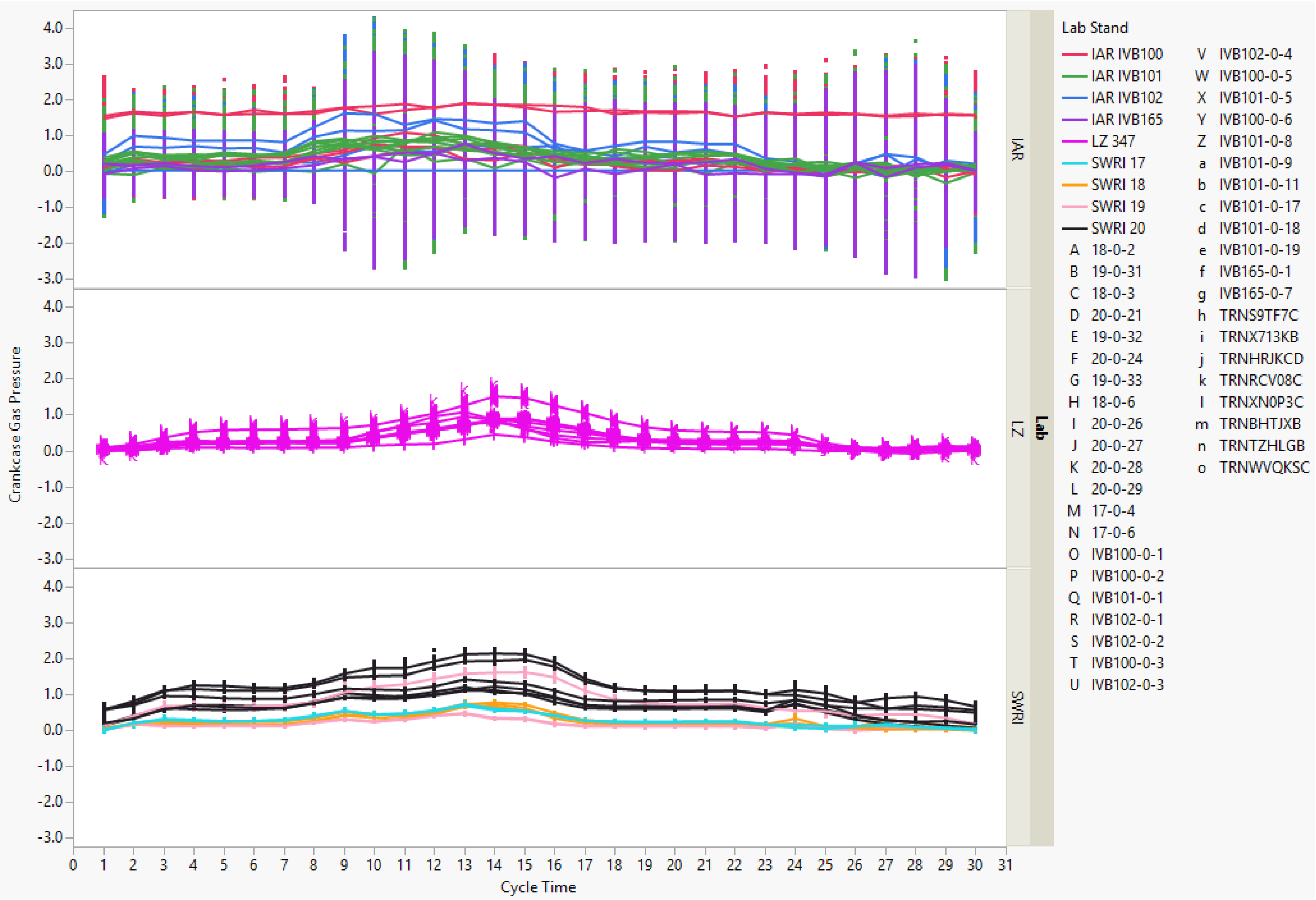


Analyses suggest differences in air fuel ratio may affect test severity.
In particular, LZ has lowest within cycle variability in stage 2.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

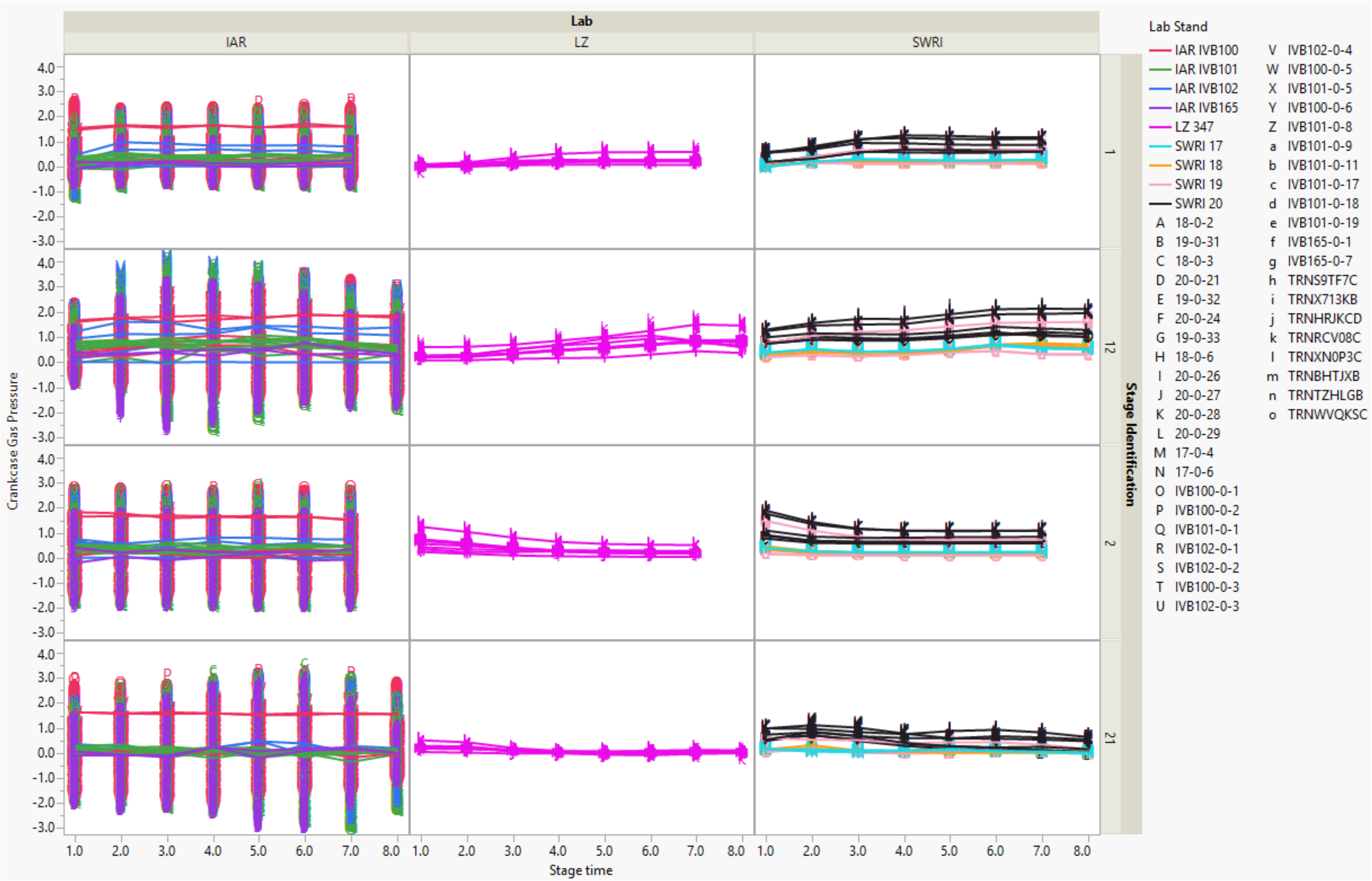


The increase in crankcase gas pressure in the transition from stage 1 to 2 generally happens a few seconds sooner at IAR than LZ and SwRI.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

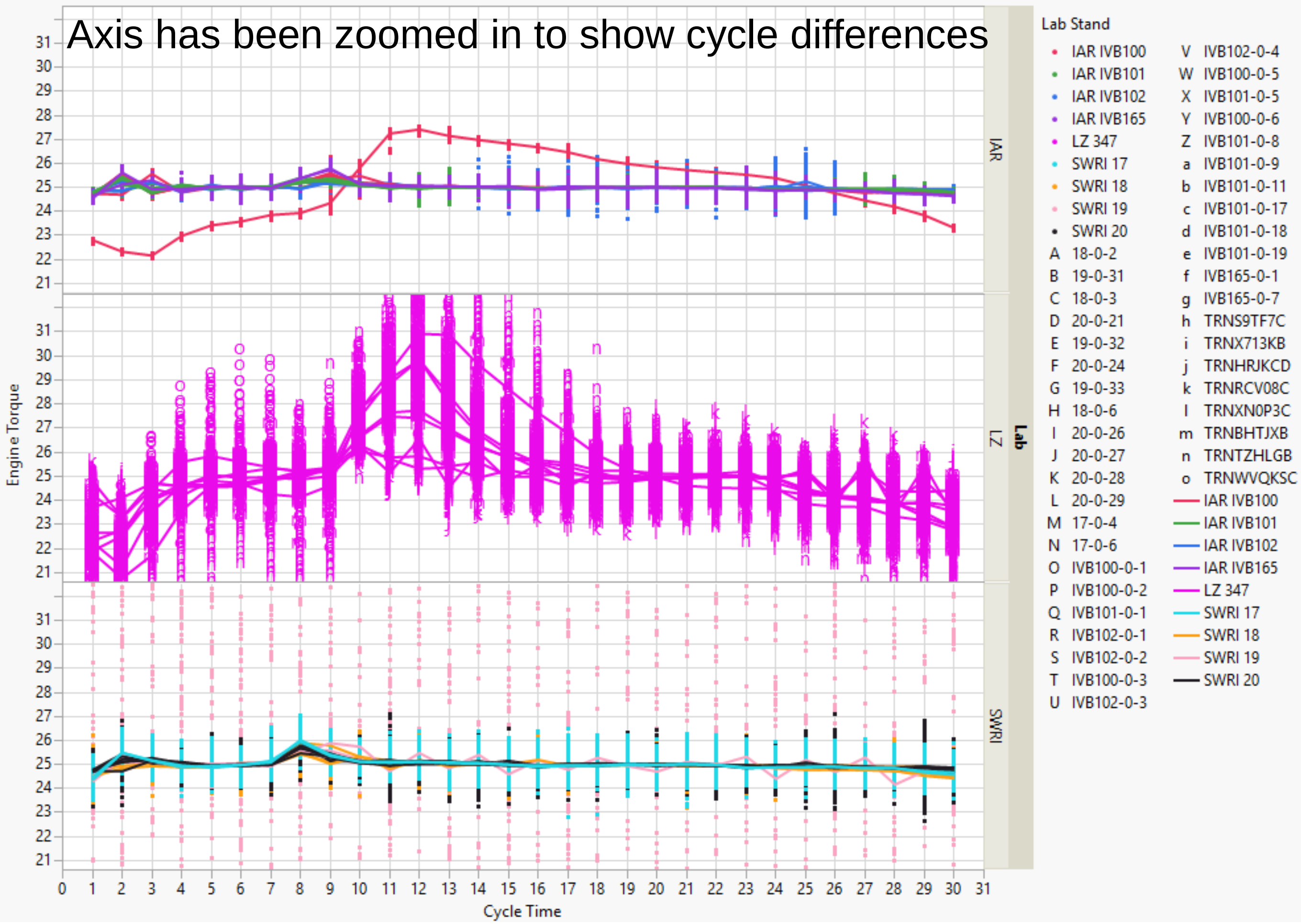


Compared to LZ and SwRI, IAR has the highest within test variability among all stages of the test.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

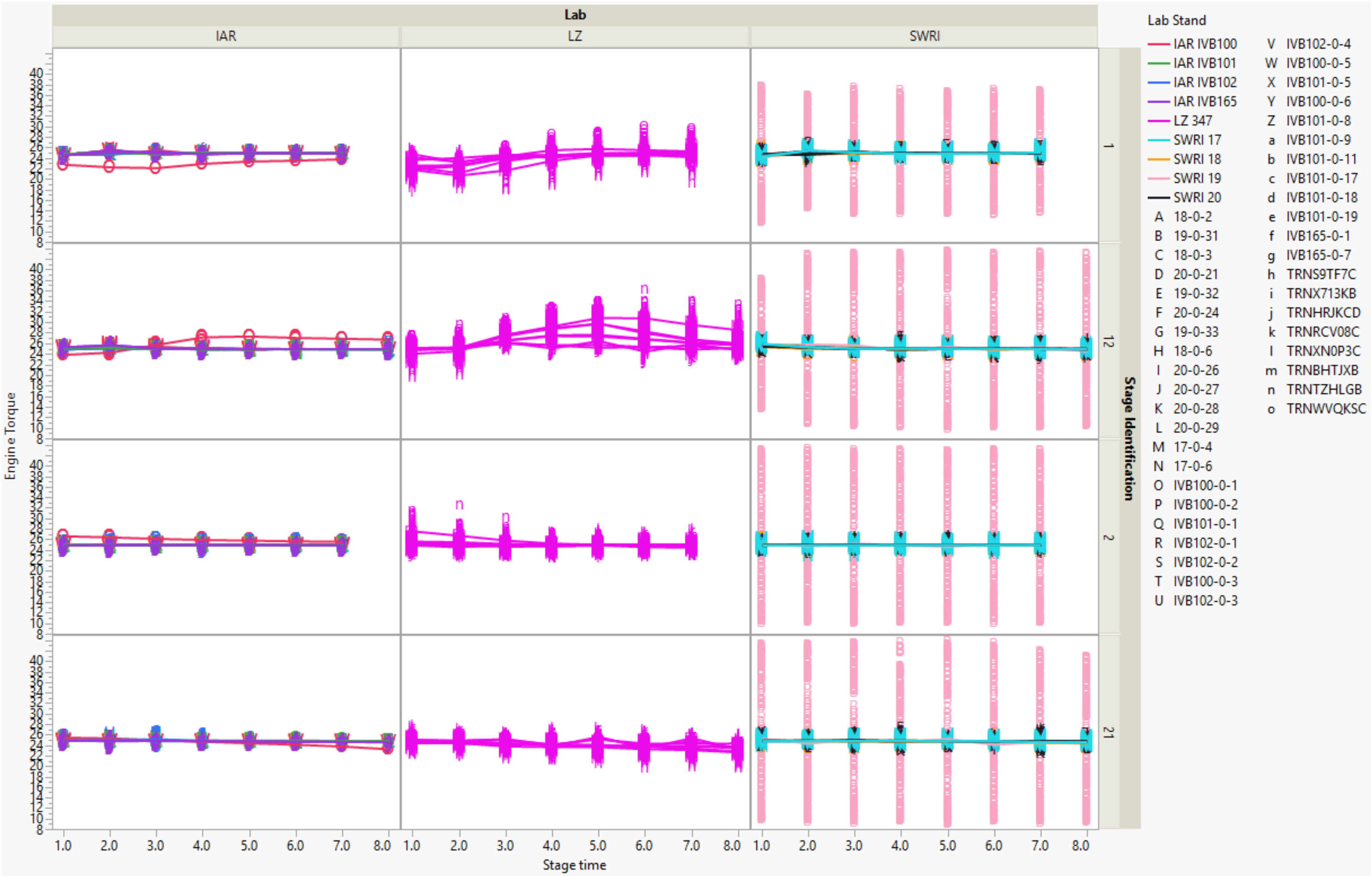


- The spike in engine torque at LZ occurs in the middle of the transition from stage 1 to stage 2 and in some tests is much higher than the spike observed at the other labs.
- SwRI's torque spikes the first second of the transition while IAR is generally 1 second behind.
- LZ also has a dip in torque at the beginning of stage 1 (this is not observed at the other labs).

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



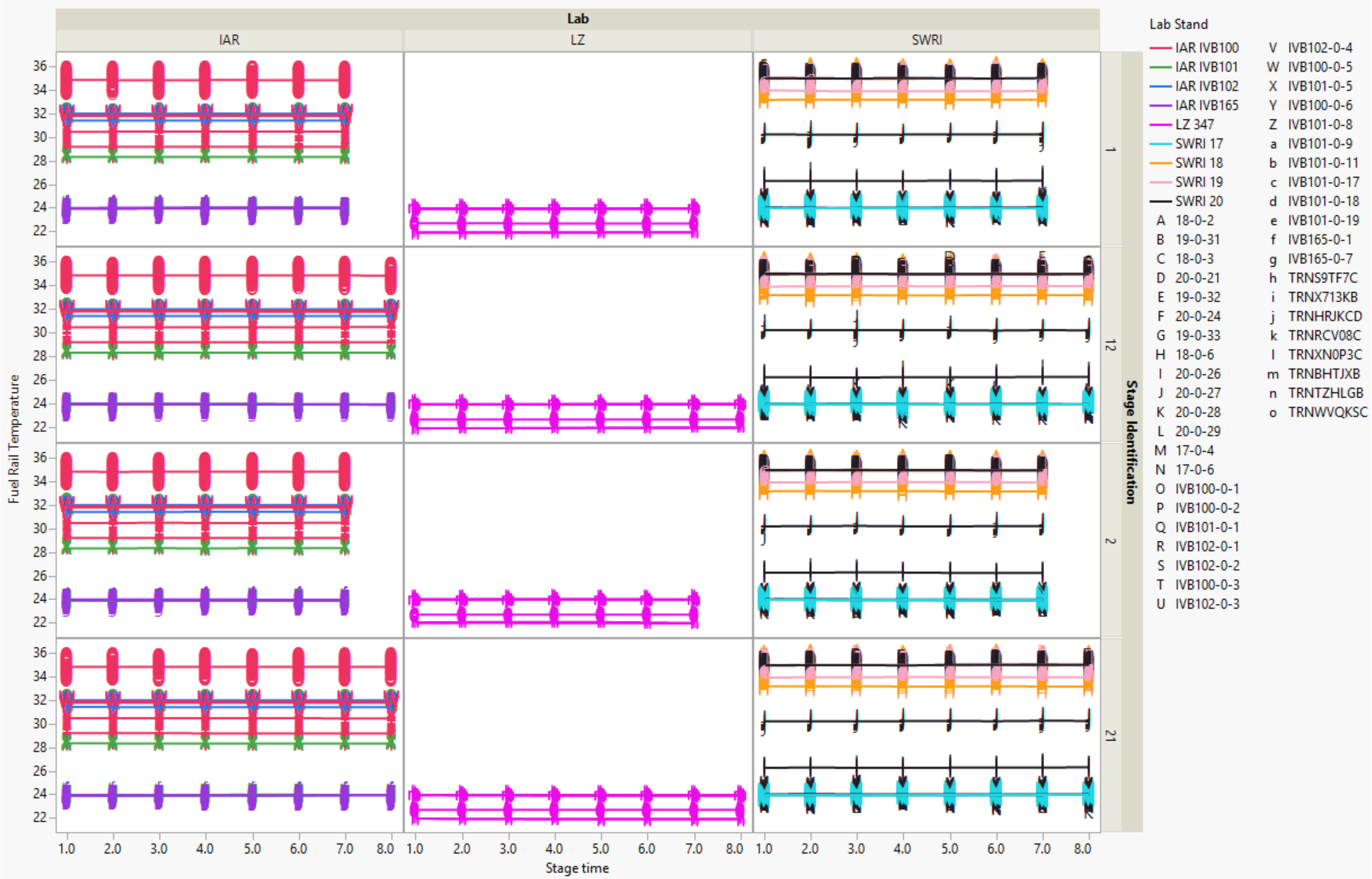
Analyses suggest differences in engine torque may affect test severity. In particular, LZ has:

- Higher average torque in the transition from stage 1 to stage 2 (caused by higher torque in a few tests)
- Slightly lower average torque in stages 1 and 21

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

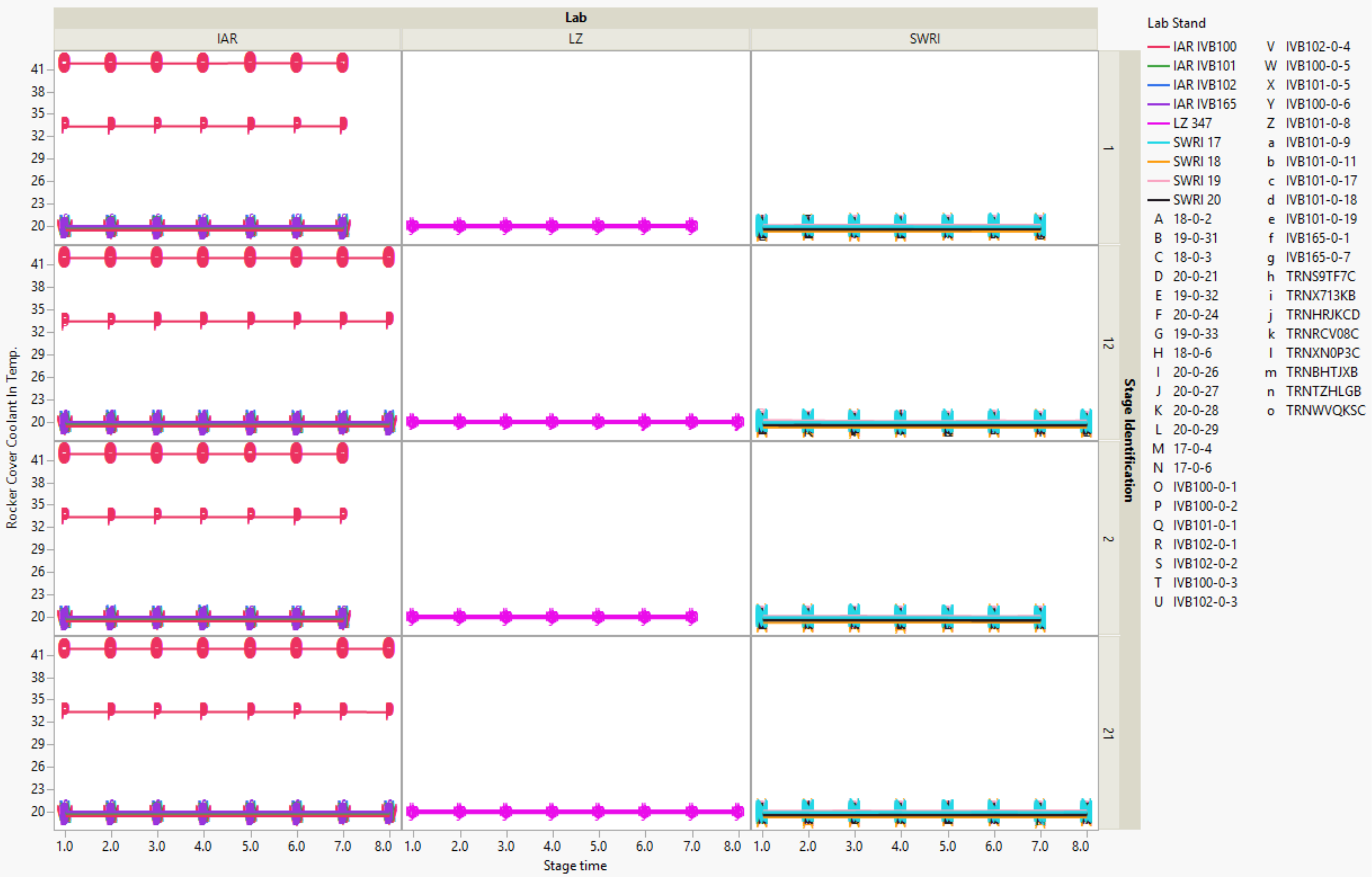


Analyses suggest differences in fuel rail temp may affect test severity. In particular, LZ and IVB102 have the lowest within cycle variability in stage 2 and the transition from stage 2 to stage 1.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss

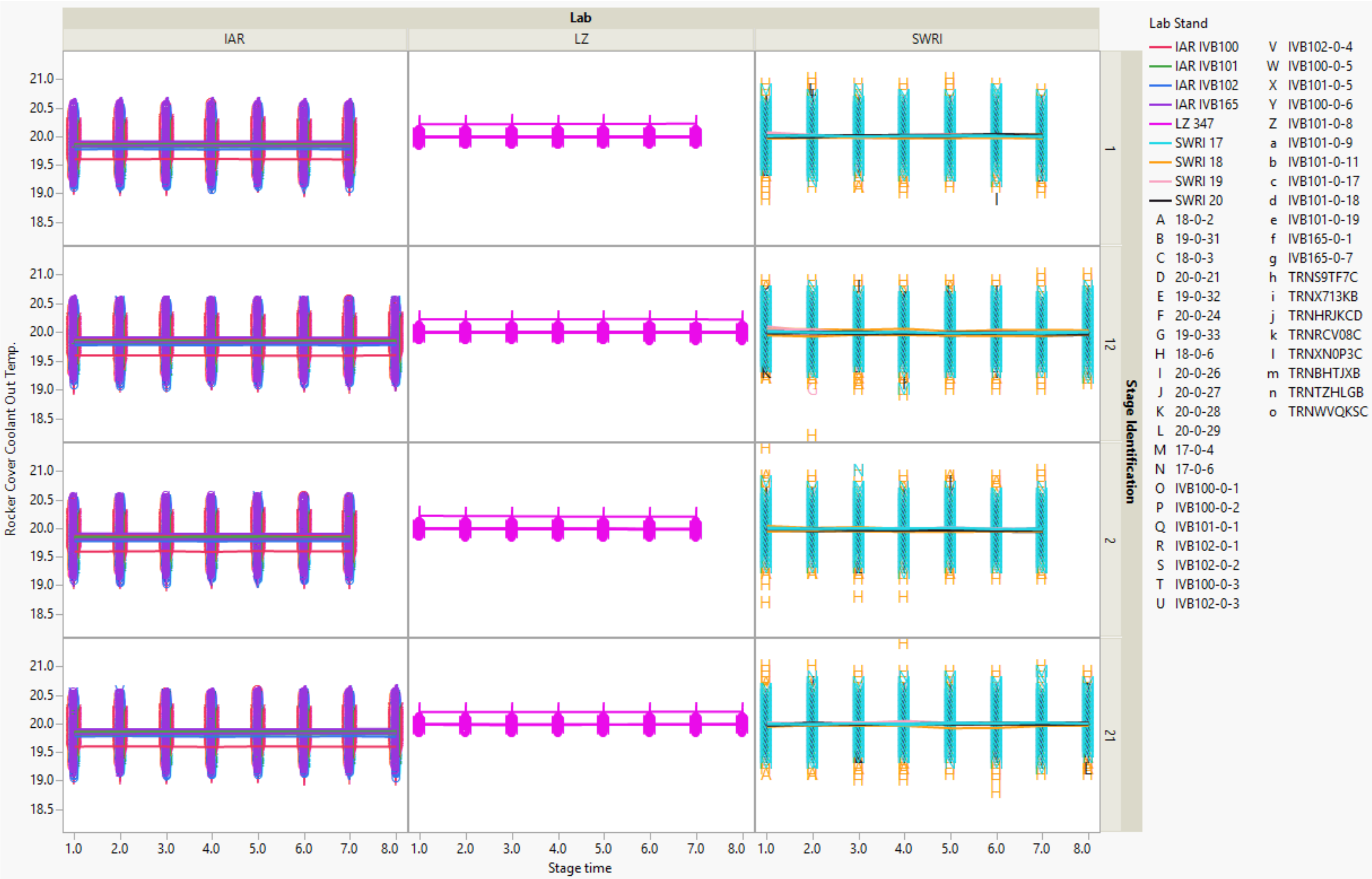
SUCCESS TOGETHER



Analyses suggest differences in rocker cover coolant in temp may affect test severity.
In particular, LZ has the lowest within cycle variability in all stages of the test.

Lubrizol

Possible Operational Differences Affecting Average Intake Lifter Area Loss



Analyses suggest differences in rocker cover coolant out temp may affect test severity. In particular, LZ has the lowest within cycle variability in all stages of the test.

Appendix A
Results by test

Appendix A – Results by Test

Final Prove-out test?	Lab	Stand	Oil	Test	Exhaust Bucket Lifters Average Area Loss, µm2	Exhaust Bucket Lifters Average Volume Loss, mm3	Average intake lifter area loss	Average intake lifter volume loss
No	IAR	IVB100	REO1006-2	IVB100-0-5			97132.831	
No	IAR	IVB100	REO300	IVB100-0-1			99565.631	
No	IAR	IVB100	REO300	IVB100-0-2			26430.975	
No	IAR	IVB101	REO1006-2	IVB101-0-11			282302.105	3.243
No	IAR	IVB101	REO1006-2	IVB101-0-19				
No	IAR	IVB101	REO300	IVB101-0-1			91561.825	
No	IAR	IVB102	REO1006-2	IVB102-0-4			139121.873	
No	IAR	IVB102	REO300	IVB102-0-1			119989.675	
No	LZ	347	REO300	TRNS9TF7C				
No	SWRI	18	REO 300	18-0-2			145353.88	
No	SWRI	18	REO 300	18-0-3			63792.838	
No	SWRI	19	1006-2	19-0-33			146385.944	1.119859703
No	SWRI	19	REO 300	19-0-31			171083.063	
No	SWRI	19	REO 300	19-0-32			69919.619	
No	SWRI	20	1006-2	20-0-21			37271.438	
No	SWRI	20	1006-2	20-0-24			81906.875	
No	SWRI	20	REO 300	20-0-29			168959.4	1.54

Appendix A – Results by Test

SUCCESS TOGETHER

Final Prove-out test?	Lab	Stand	Oil	Test	Exhaust Bucket Lifters Average Area Loss, µm2	Exhaust Bucket Lifters Average Volume Loss, mm3	Average intake lifter area loss	Average intake lifter volume loss
Yes	IAR	IVB100	REO1006-2	IVB100-0-3	106951.9		179553.814	
Yes	IAR	IVB100	REO3	IVB100-0-6	81629.484	1.105	102010.707	0.704
Yes	IAR	IVB101	REO1006-2	IVB101-0-17	208444.448	2.064243265	256481.937	2.364
Yes	IAR	IVB101	REO1006-2	IVB101-0-18	131544.454	0.956906187	200097.992	1.592
Yes	IAR	IVB101	REO3	IVB101-0-8	59174.488	0.61	116375.183	0.982
Yes	IAR	IVB101	REO300	IVB101-0-5	83197.74		239274.467	
Yes	IAR	IVB101	REO300	IVB101-0-9	143407.848	1.724	265339.906	2.51
Yes	IAR	IVB102	REO1006-2	IVB102-0-2	82004.91		145893.659	
Yes	IAR	IVB102	REO1006-2	IVB102-0-3	103052.31		171764.073	
Yes	IAR	IVB165	REO1006-2	IVB165-0-1	85838.184	0.846680813	153717.036	1.337
Yes	IAR	IVB165	REO300	IVB165-0-7	71669.706	0.742	123761.196	1.14
Yes	LZ	347	REO1006-2	TRNHRJKCD	113196.5625	1.47377436	279284	2.683
Yes	LZ	347	REO1006-2	TRNRCV08C	130022.4375	1.771258125	261655	2.799
Yes	LZ	347	REO1006-2	TRNXN0P3C	168046.6875	2.38	268600	2.807
Yes	LZ	347	REO1006-2	TRNBHTJXB	176535.6875	2.29025	292911	3.037
Yes	LZ	347	REO3	TRNWVQKSC		2.089375		3.881
Yes	LZ	347	REO300	TRNX713KB	172282.2238	2.367856633	378016	4.272
Yes	LZ	347	REO300	TRNTZHLGB	133624.6875	1.834625	353890	3.746
Yes	SWRI	17	1006-2	17-0-4	108780	0.76	363430.67	3.72
Yes	SWRI	17	1006-2	17-0-6	125168.49	1.25	307683.39	3.13
Yes	SWRI	18	REO 300	18-0-6	104167.79	0.74	301517.988	2.934891747
Yes	SWRI	20	1006-2	20-0-28	85558.62	0.85	203830.314	1.804
Yes	SWRI	20	REO 300	20-0-26	107097.99	0.87	244466.725	1.875
Yes	SWRI	20	REO 300	20-0-27	122576.406	1.04	286161.088	1.75

Being Confirmed

Lubrizol

Appendix B

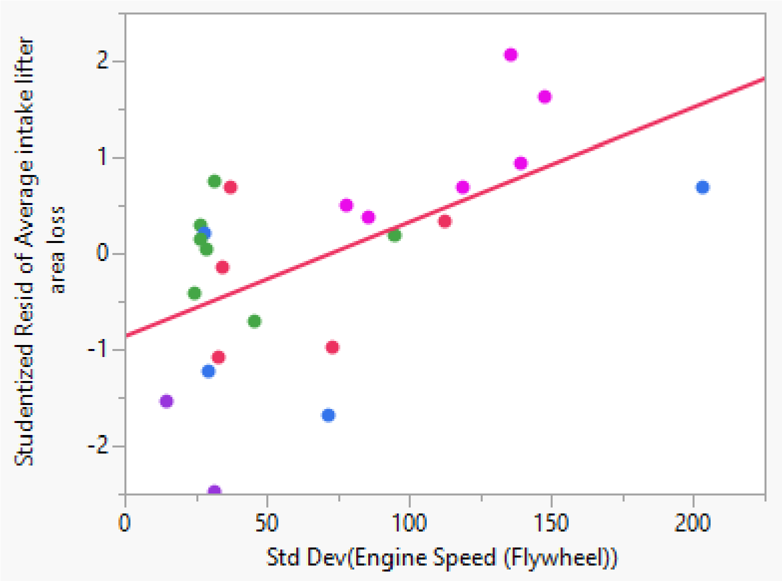
Possible Operational Differences Affecting Average Intake Lifter Area Loss

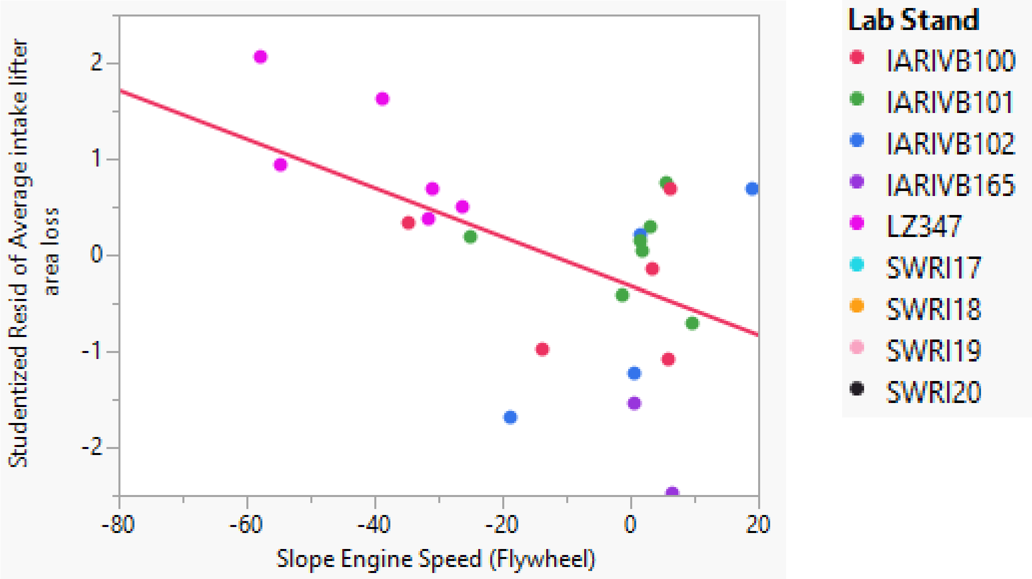
Correlation to Average Intake Area Loss

- Operational data were collected from 101 and 102 hours of each test.
  - Each test contains 120 cycles (each cycle is 30 seconds)
  - Each cycle consists of 4 stages:
    - Stage 1 (7 seconds)
    - Stage 12: the transition from stage 1 to stage 2 (8 seconds)
    - Stage 2 (7 seconds)
    - Stage 21: the transition from stage 2 to stage 1 (8 seconds)
- Within each stage of each test, the mean, median, standard deviation, and slope (where applicable) were calculated across the 120 cycles.
- Variability in average intake area loss attributed to oil and test length differences was removed.
  - Studentized residuals were calculated. These represent the remaining variability in the data after oil differences and the test length effect are taken into account.
- The studentized residuals were then correlated with the summarized operational data metrics to identify operational differences potentially affecting test severity.
- Plots of these correlations are included in this appendix.

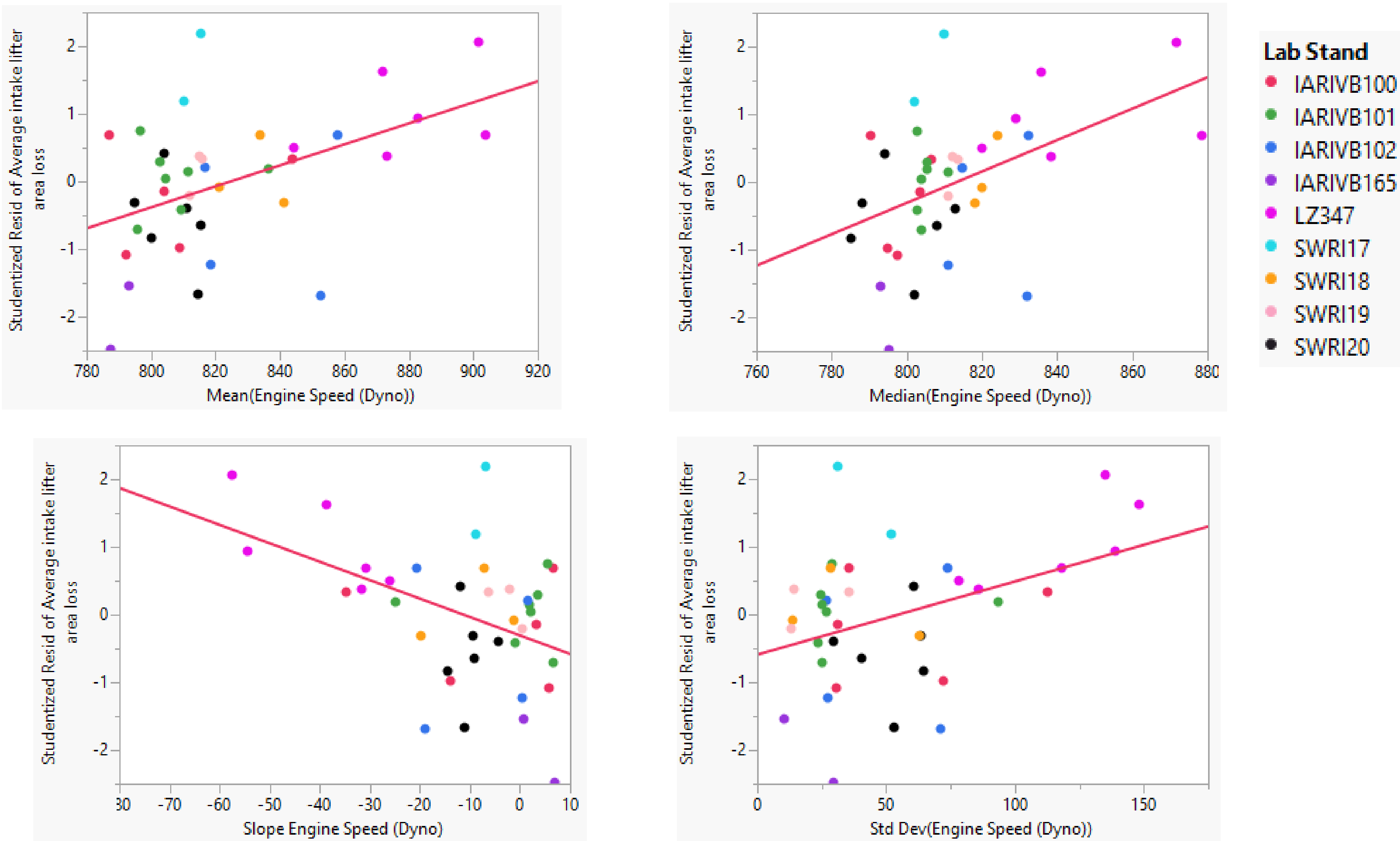
Possible **Stage 1** Operational Differences Affecting Average Intake Lifter Area Loss

Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

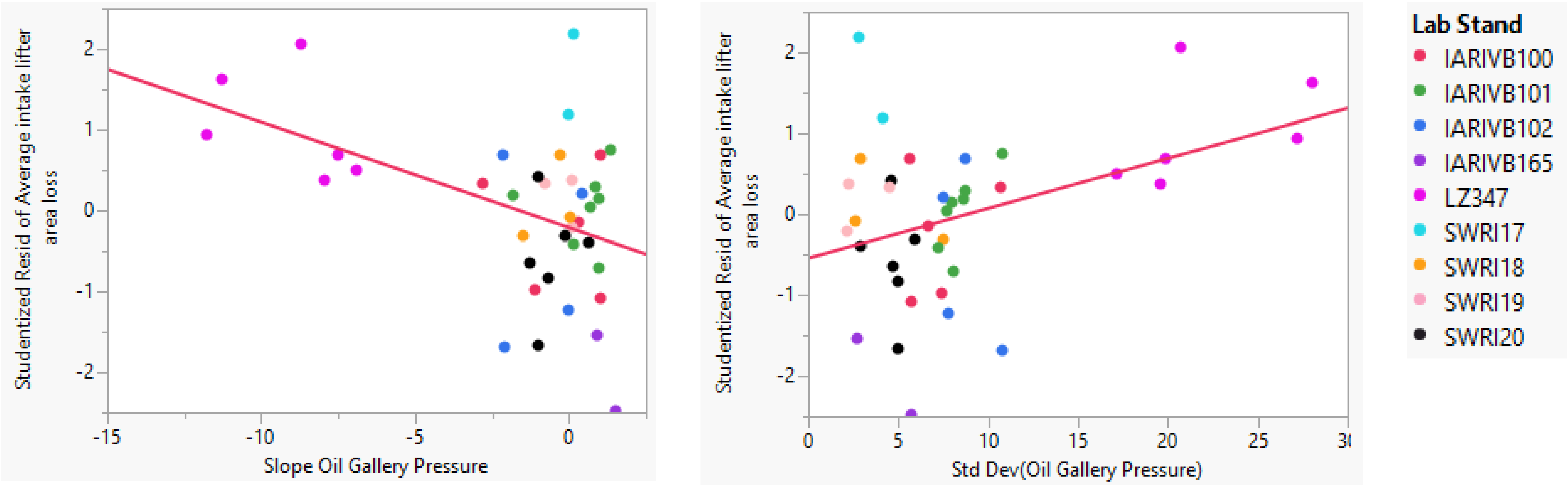




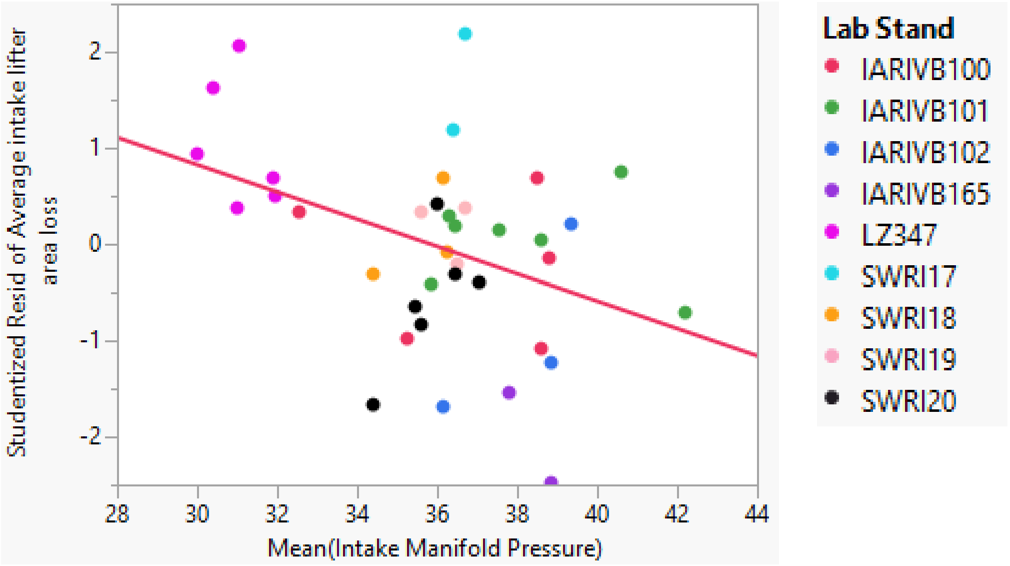
Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss



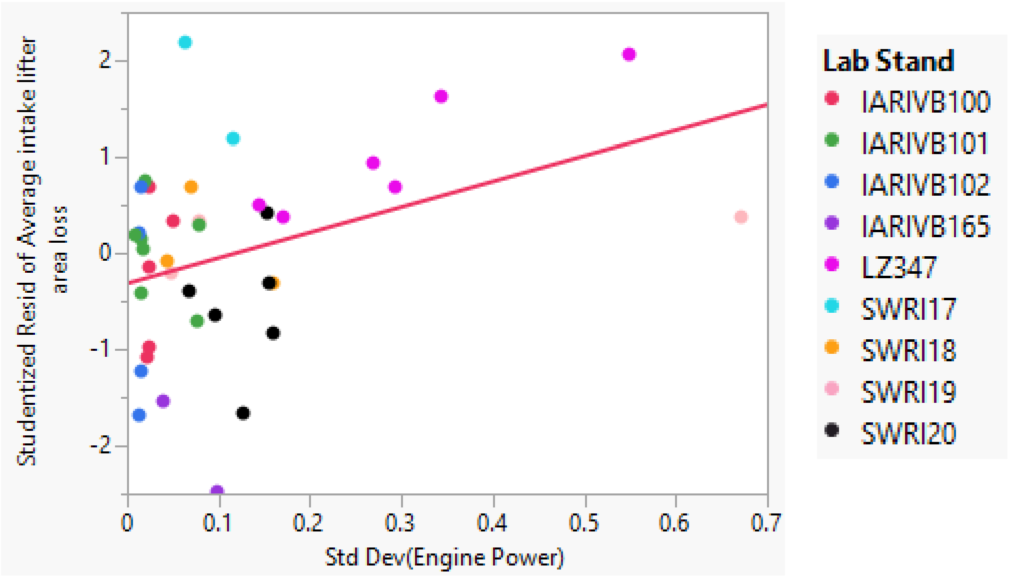
Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss



Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

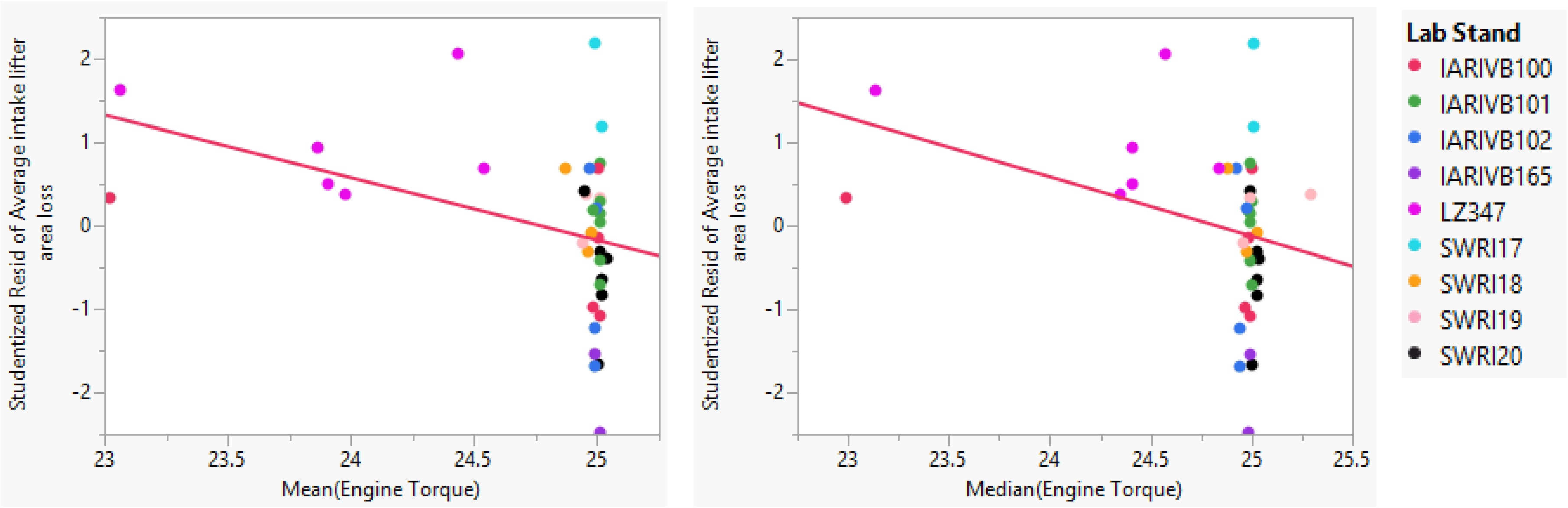


Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss



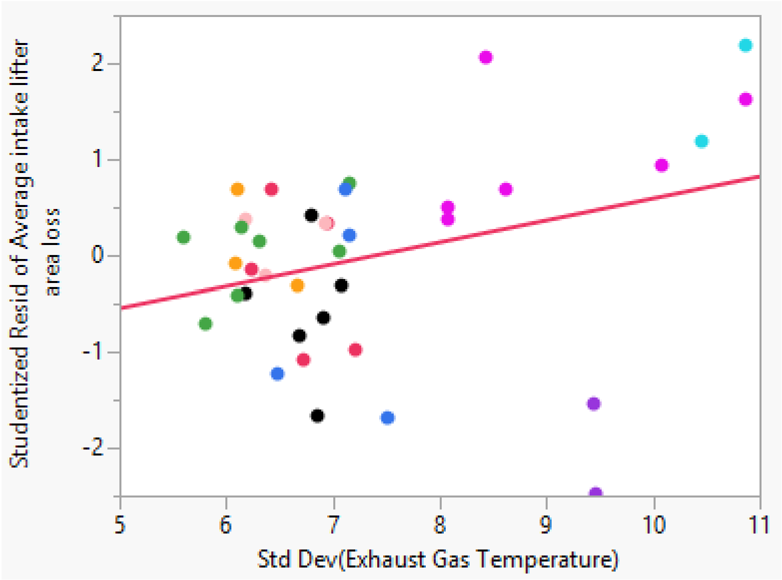
Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

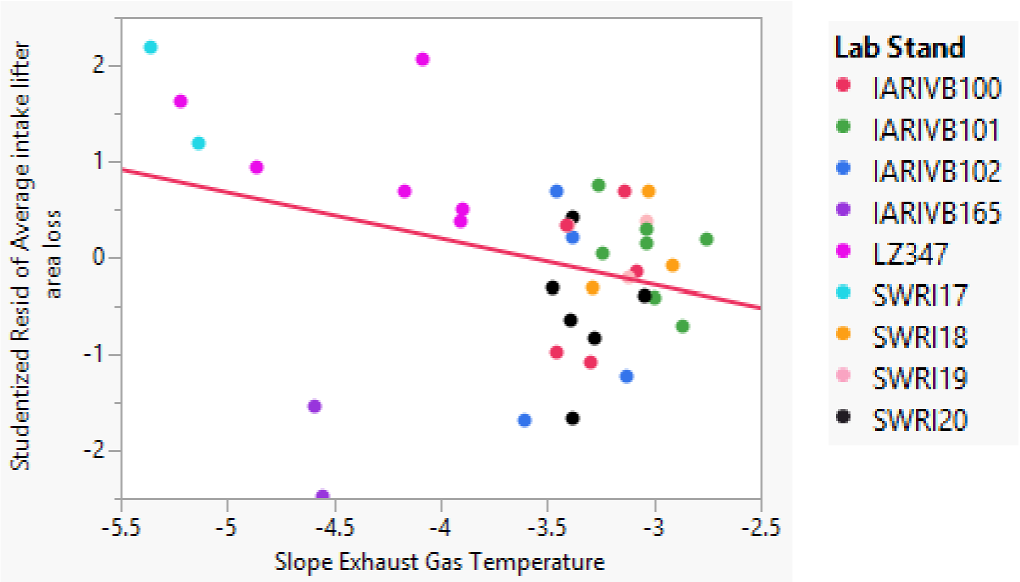
SUCCESS TOGETHER



Lubrizol

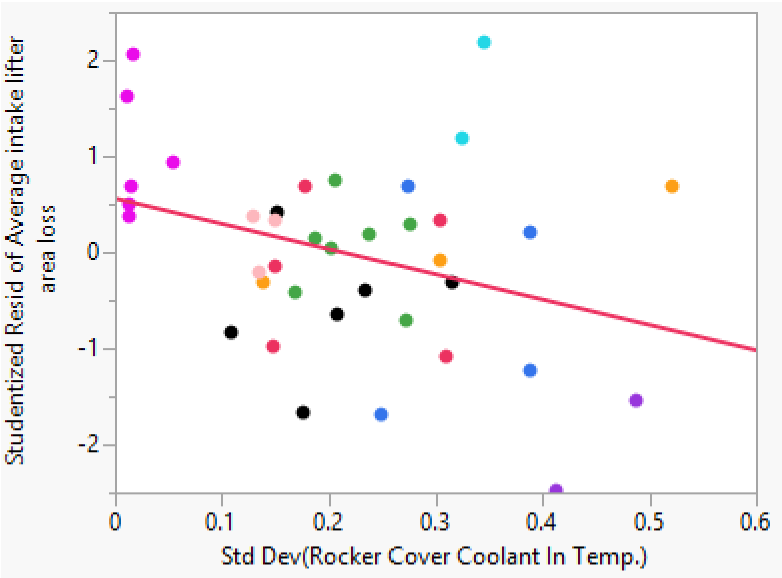
Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

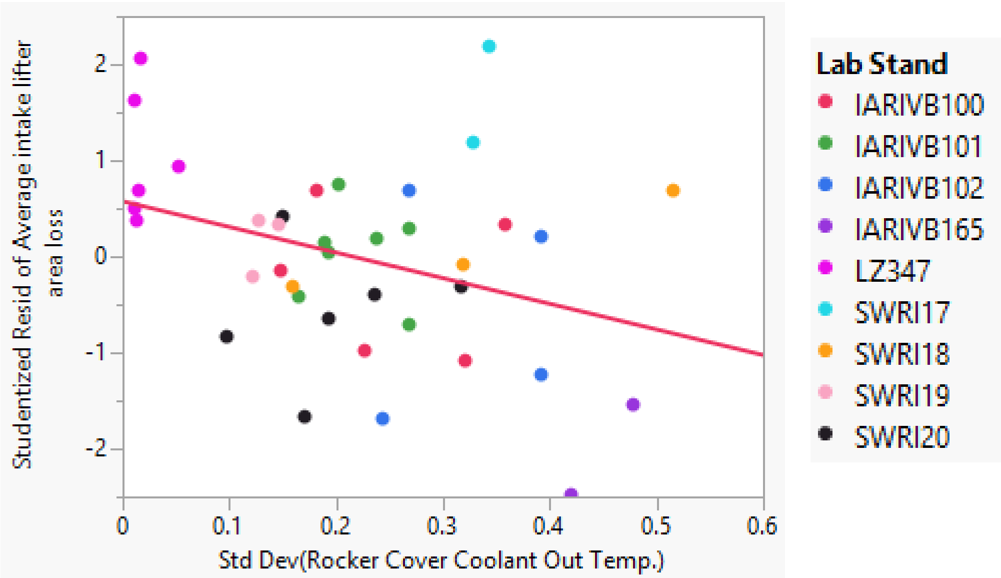




Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

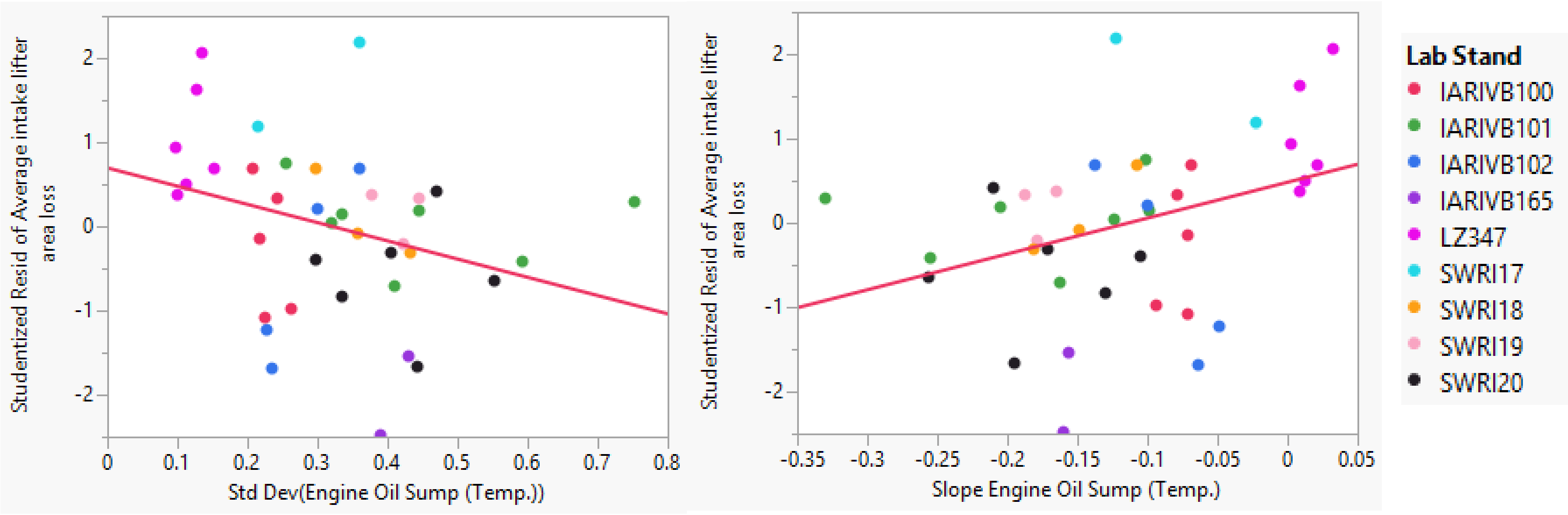
SUCCESS TOGETHER





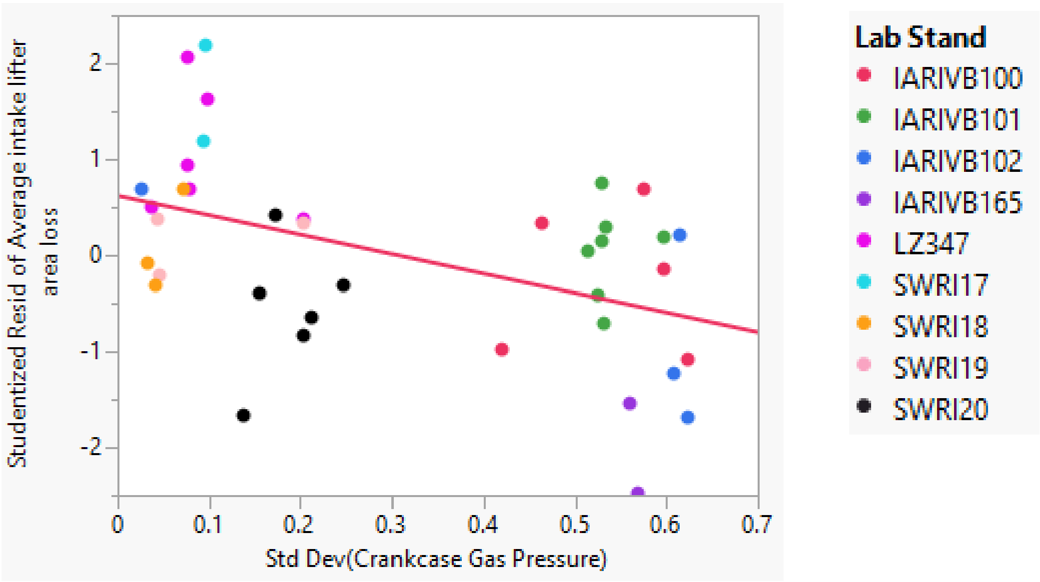
Lubrizol

Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss



Possible Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



Lubrizol

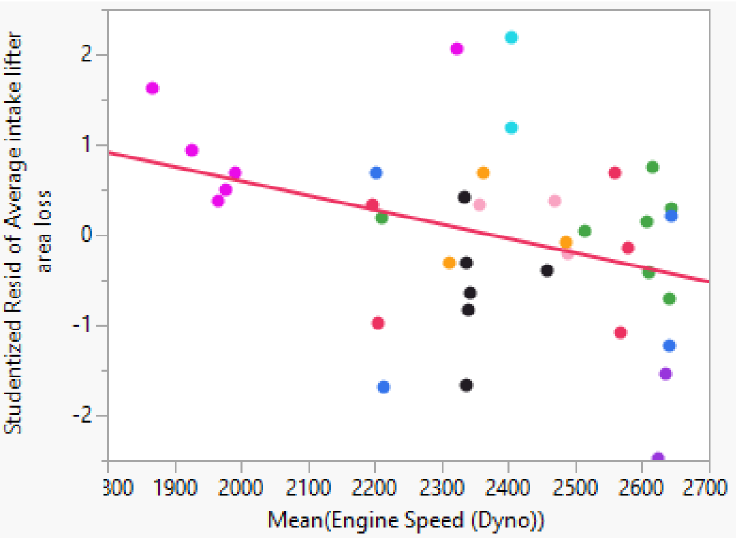
SUCCESS TOGETHER

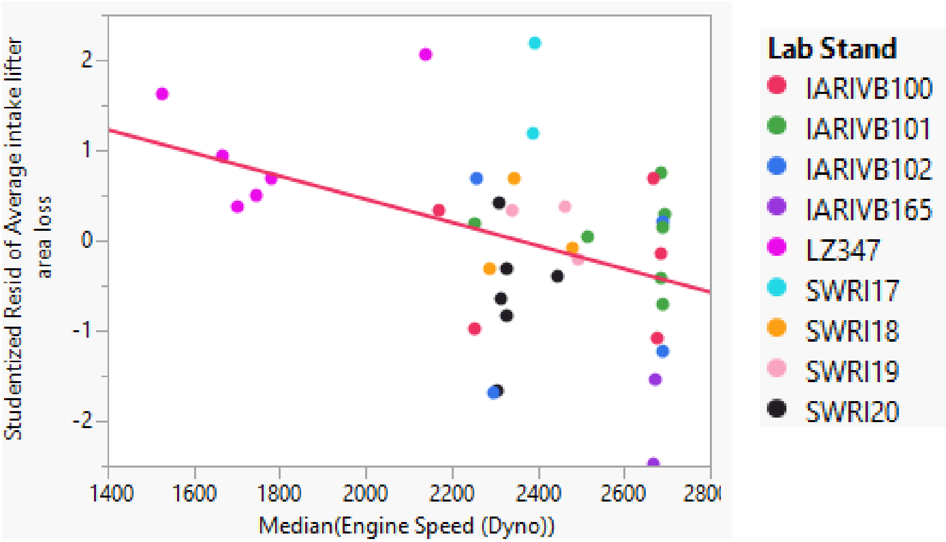
Possible **Stage 1 to Stage 2 Transition** Operational Differences Affecting Average Intake Lifter Area Loss

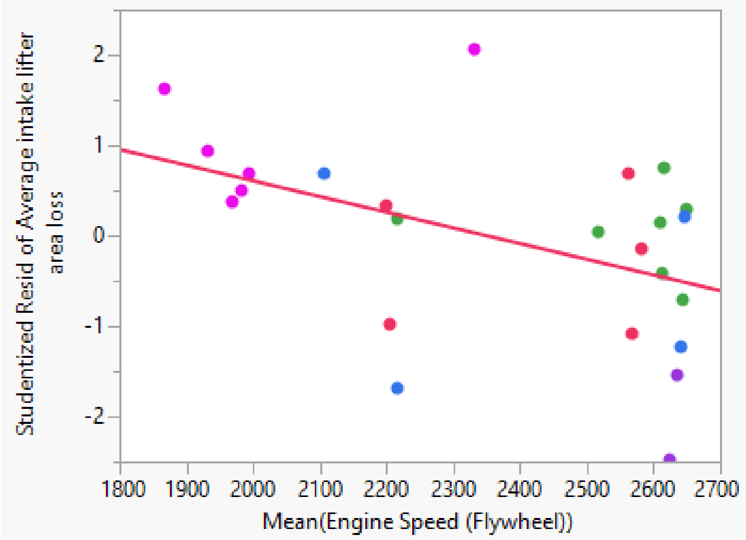
Lubrizol

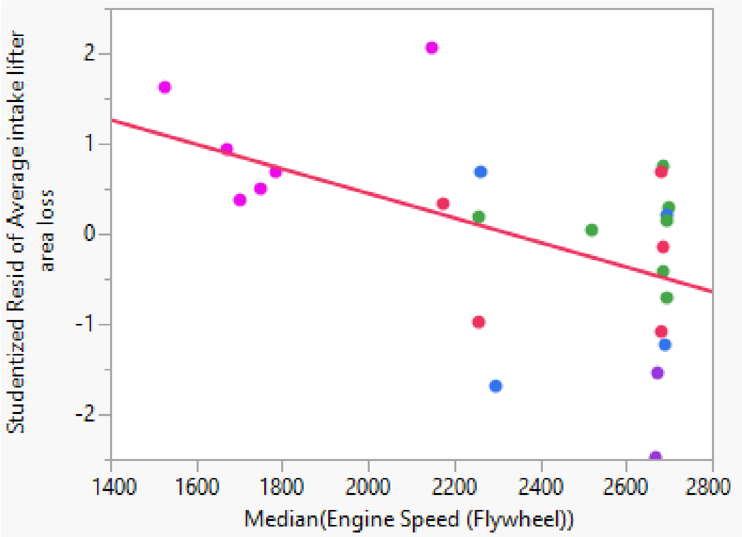
Possible Stage 1 to Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



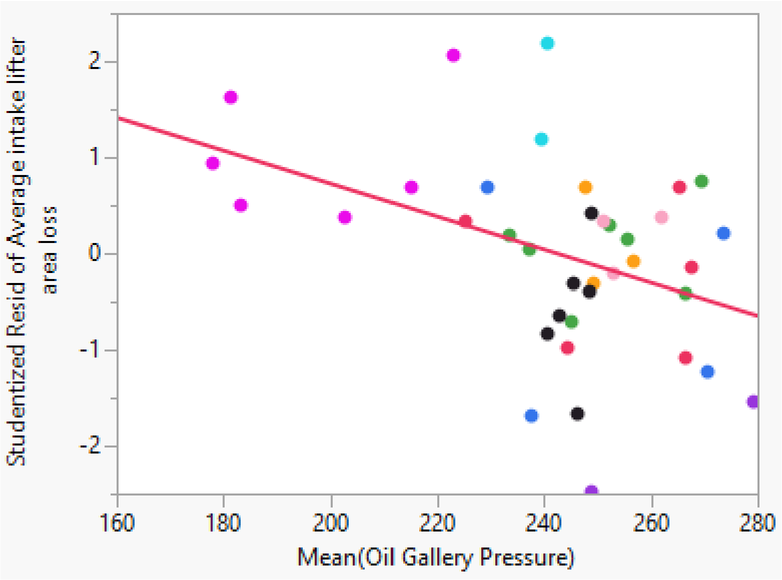


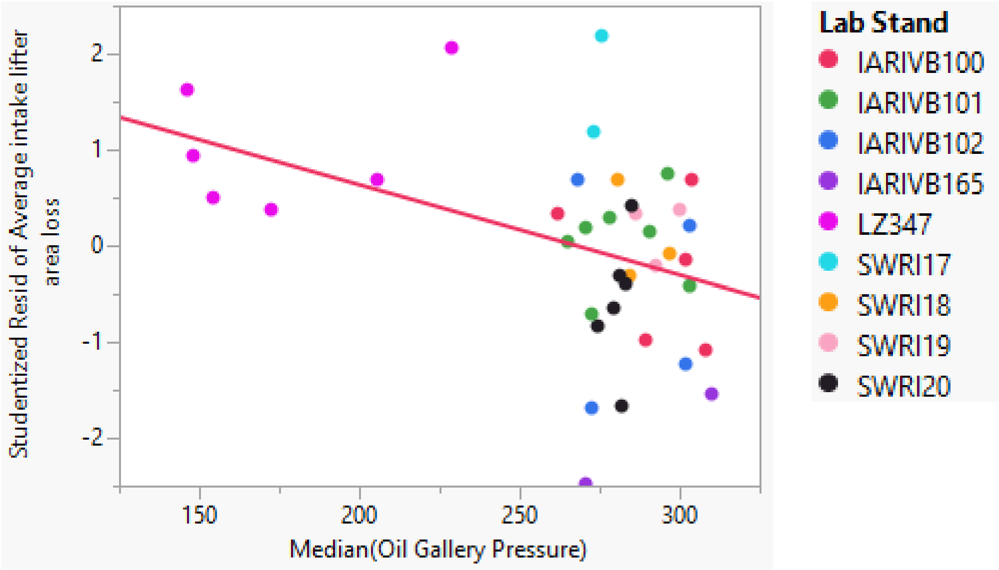




Lubrizol

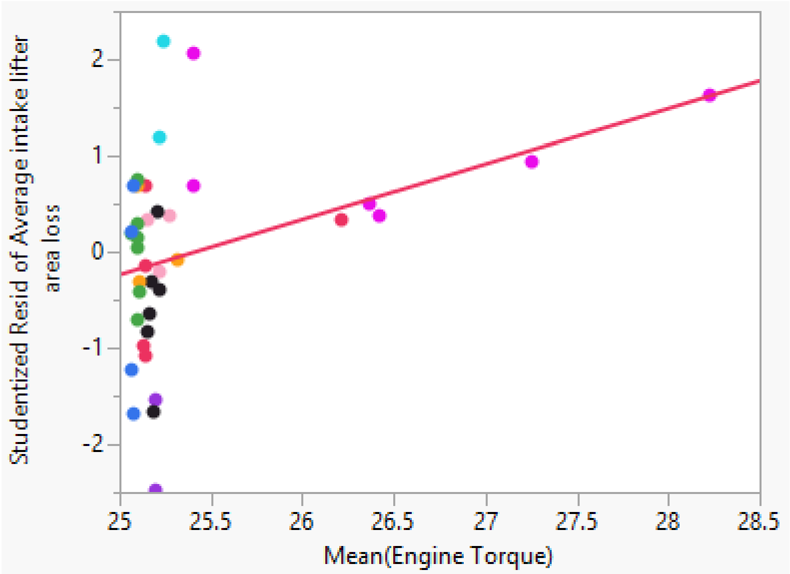
Possible Stage 1 to Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

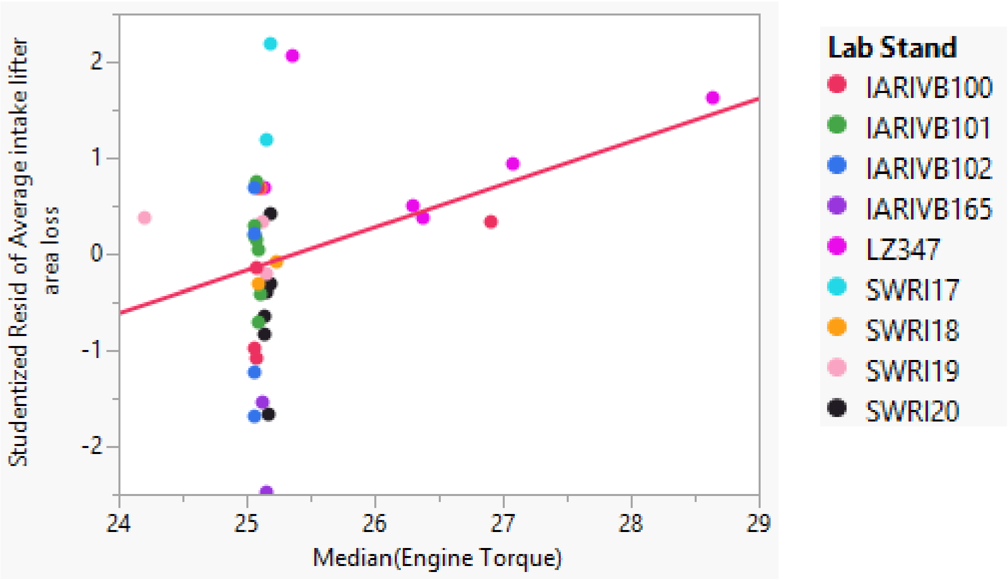




Possible Stage 1 to Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

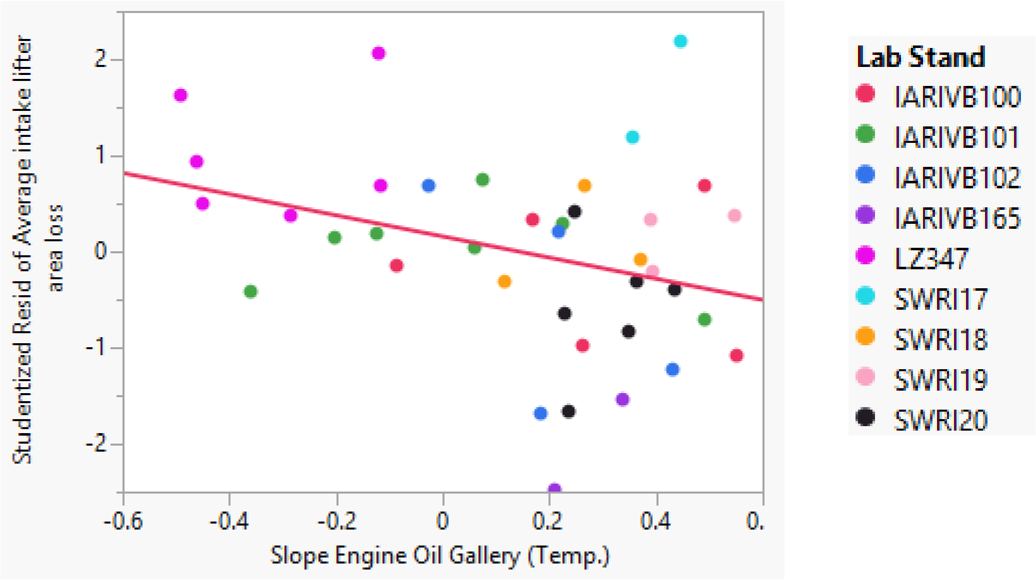




Lubrizol

Possible Stage 1 to Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

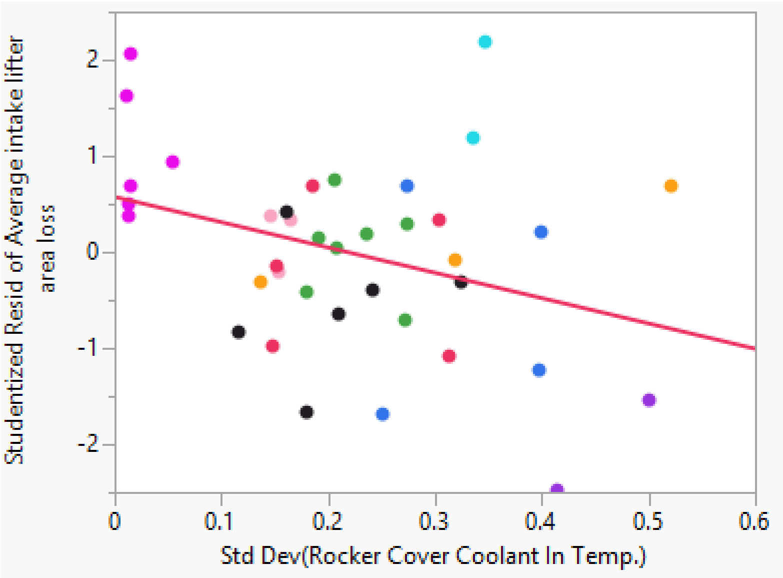
SUCCESS TOGETHER

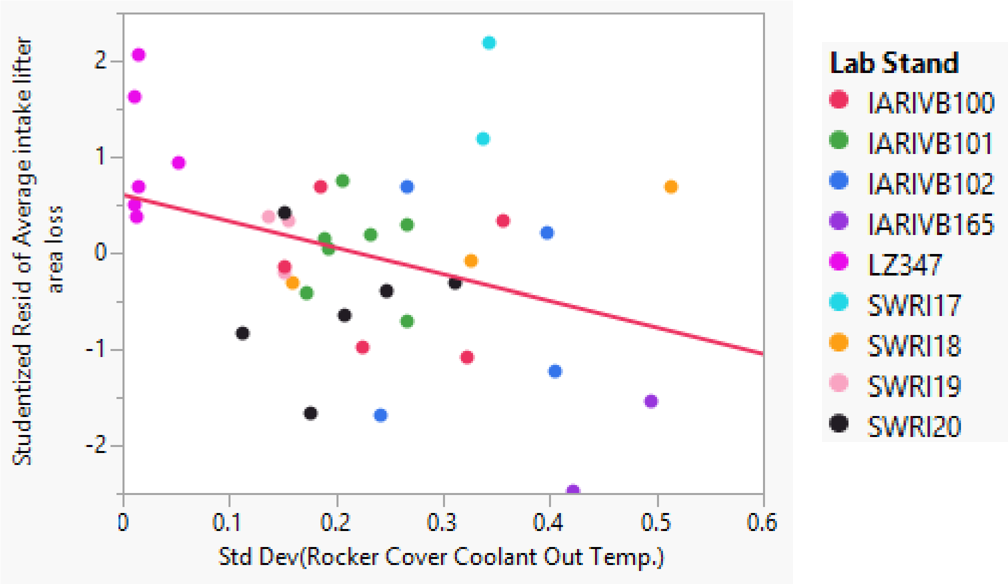


Lubrizol

Possible Stage 1 to Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

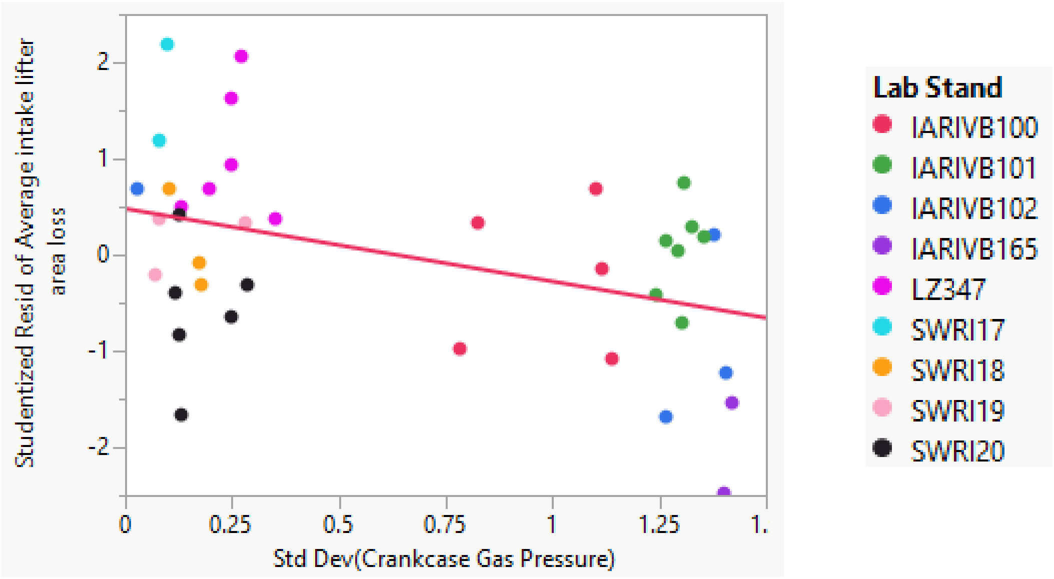
SUCCESS TOGETHER





Lubrizol

Possible Stage 1 to Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

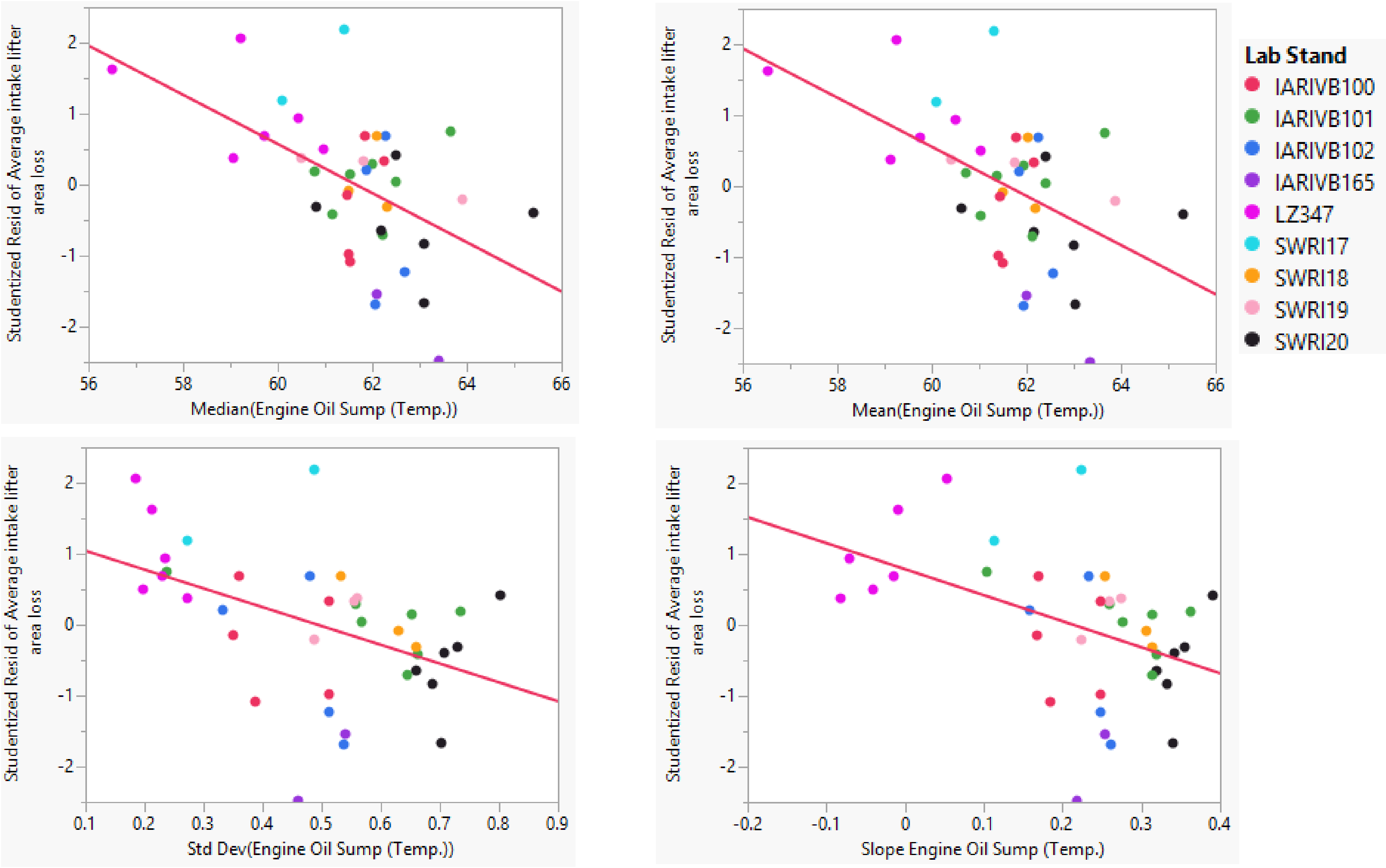


SUCCESS TOGETHER

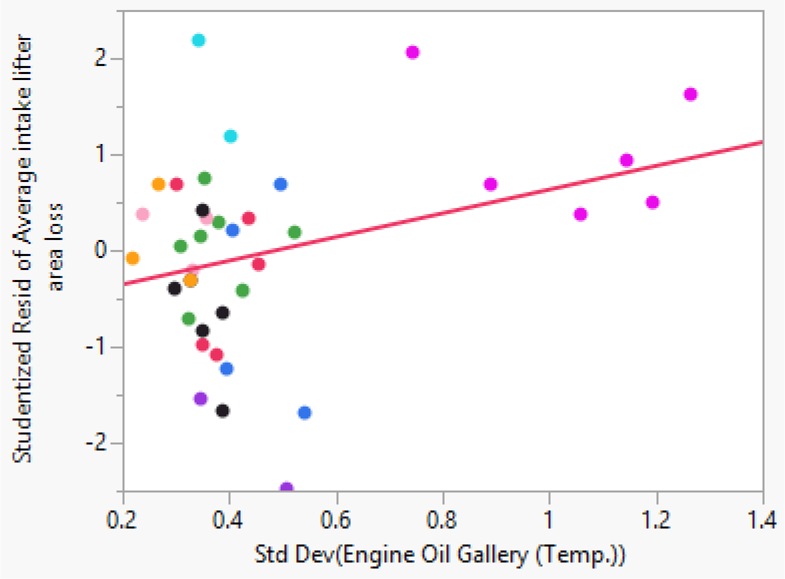
Possible **Stage 2** Operational Differences Affecting Average Intake Lifter Area Loss

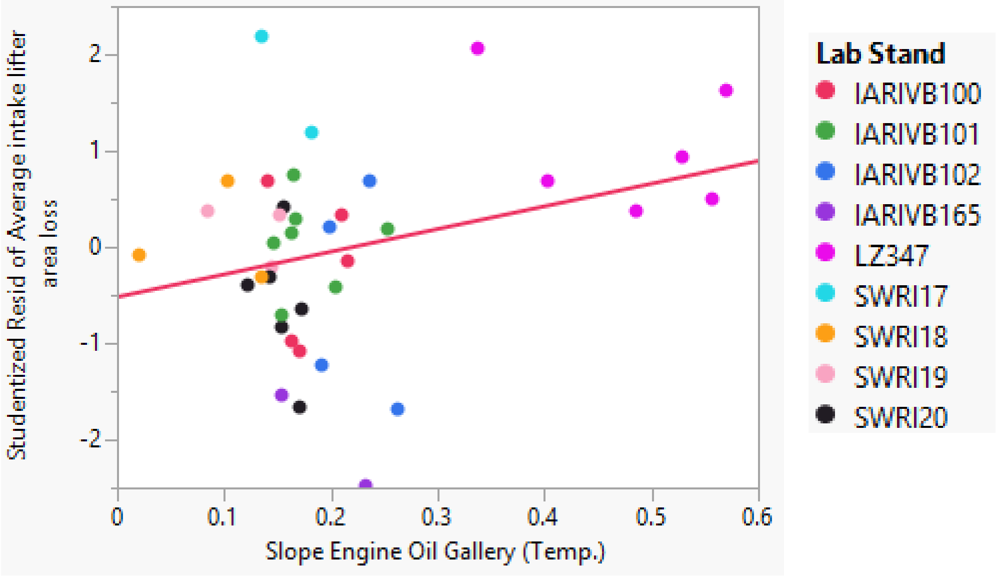
Lubrizol

Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

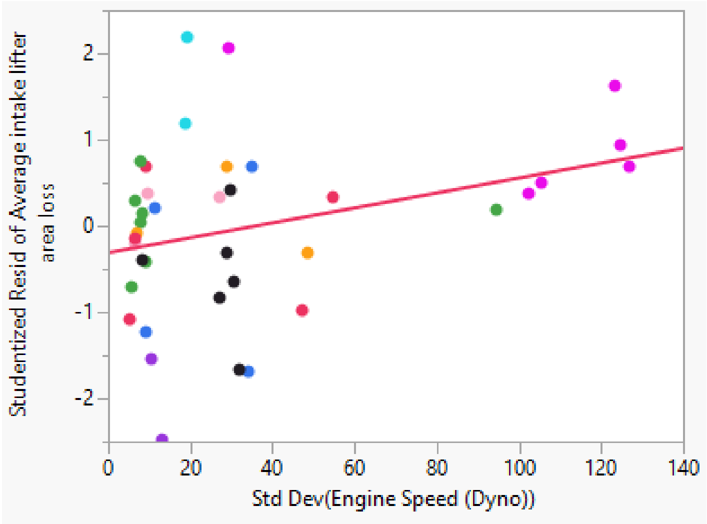


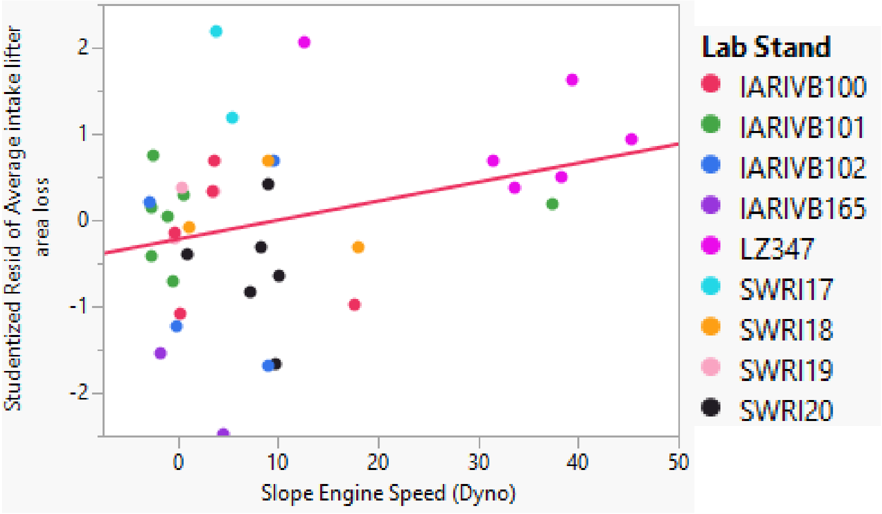
Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

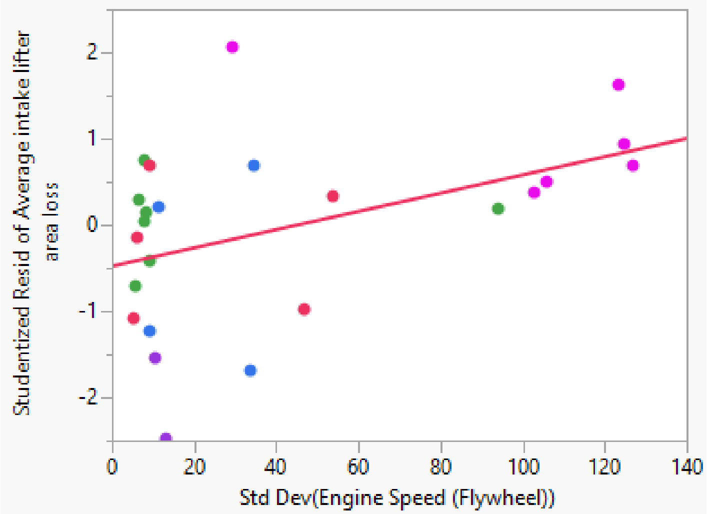


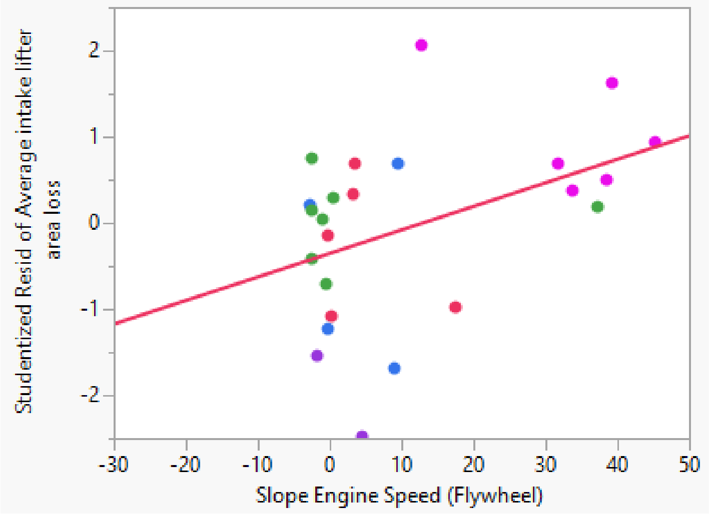


Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss



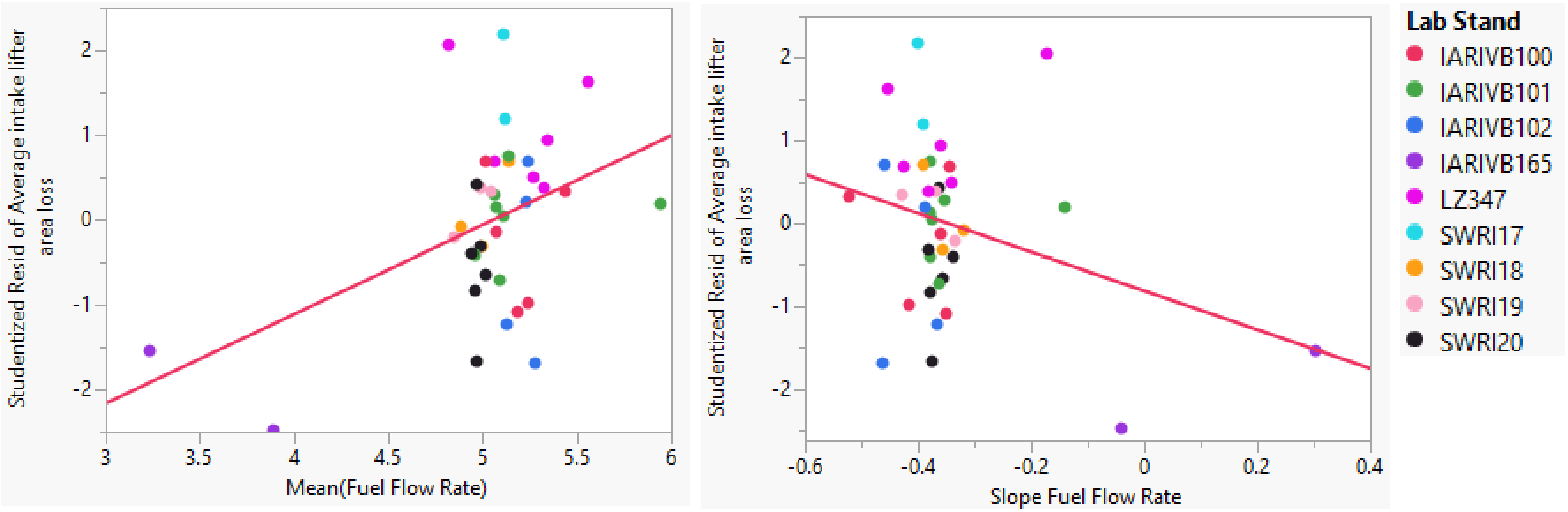






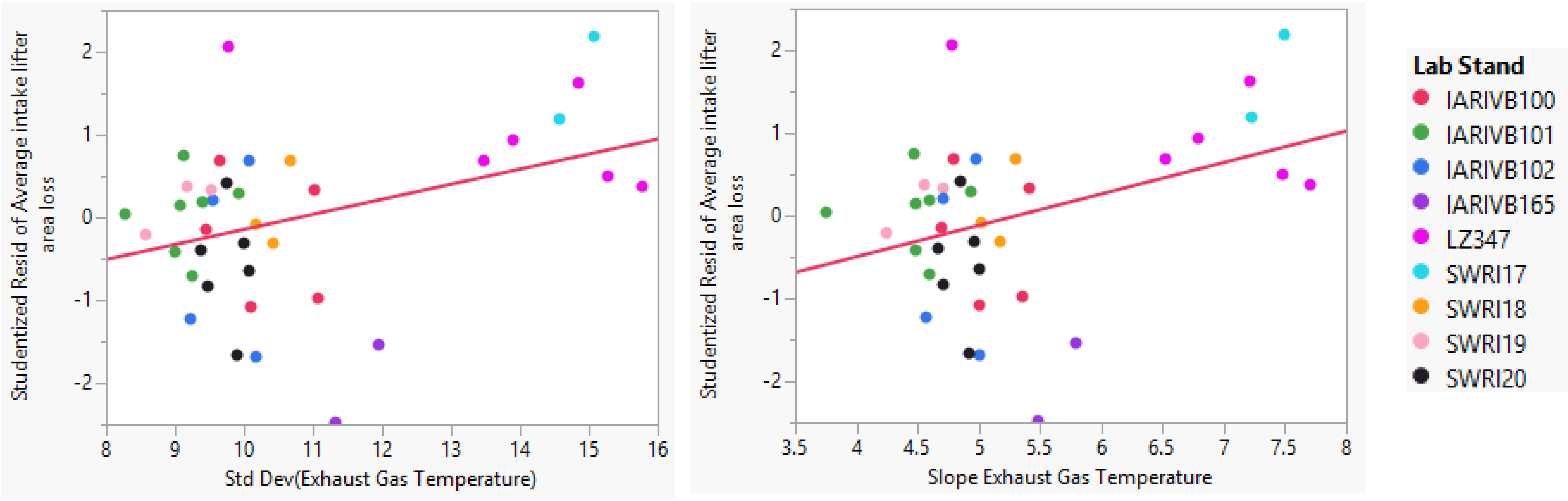
Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

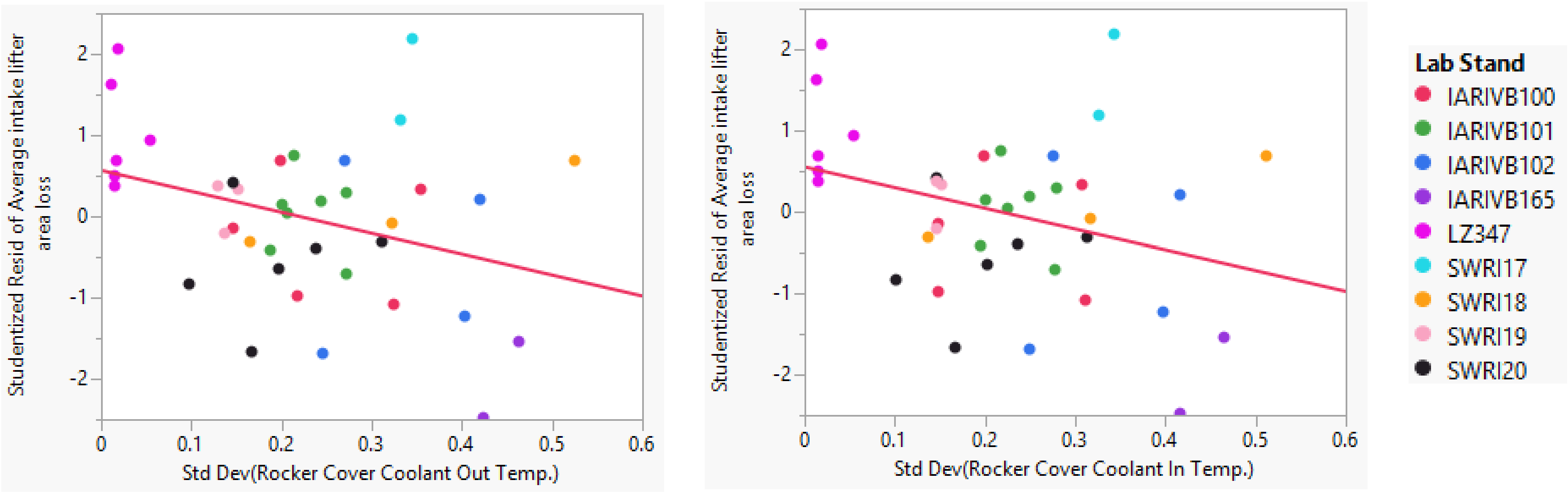


Lubrizol

Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

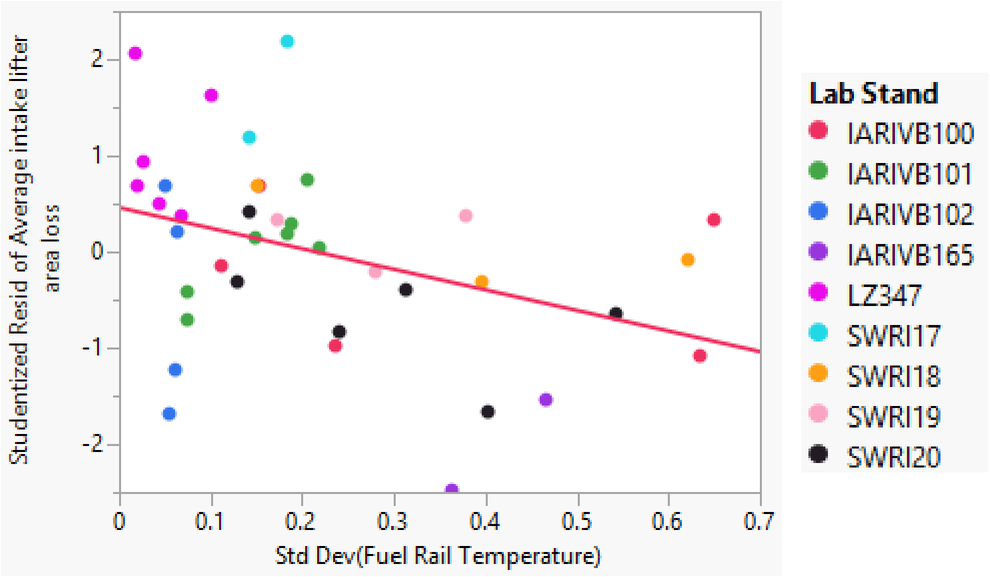


Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss



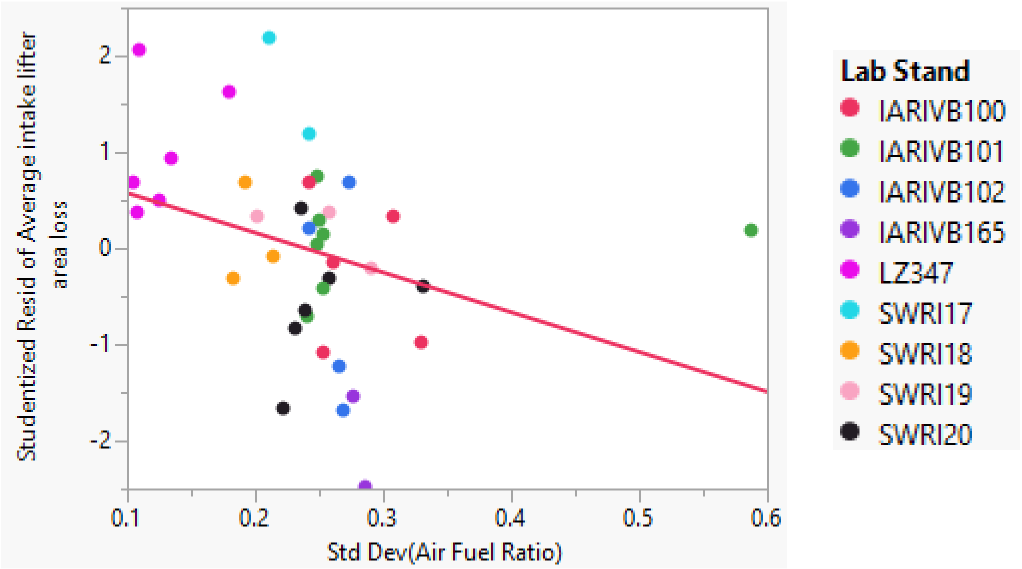
Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



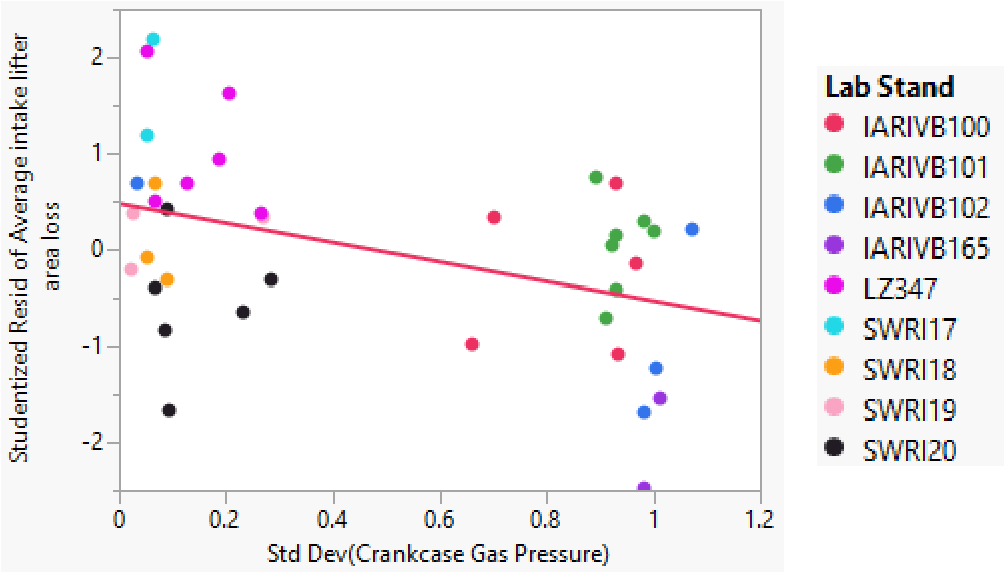
Lubrizol

Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss



Possible Stage 2 Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



Lubrizol

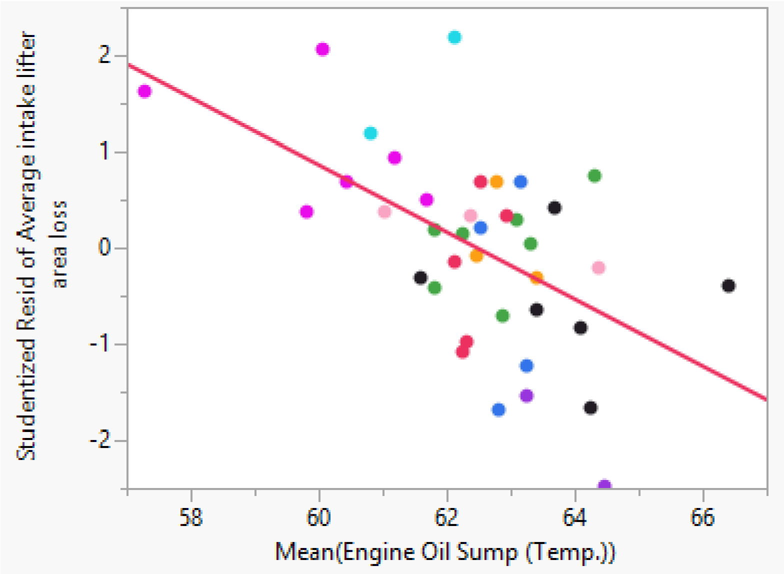
SUCCESS TOGETHER

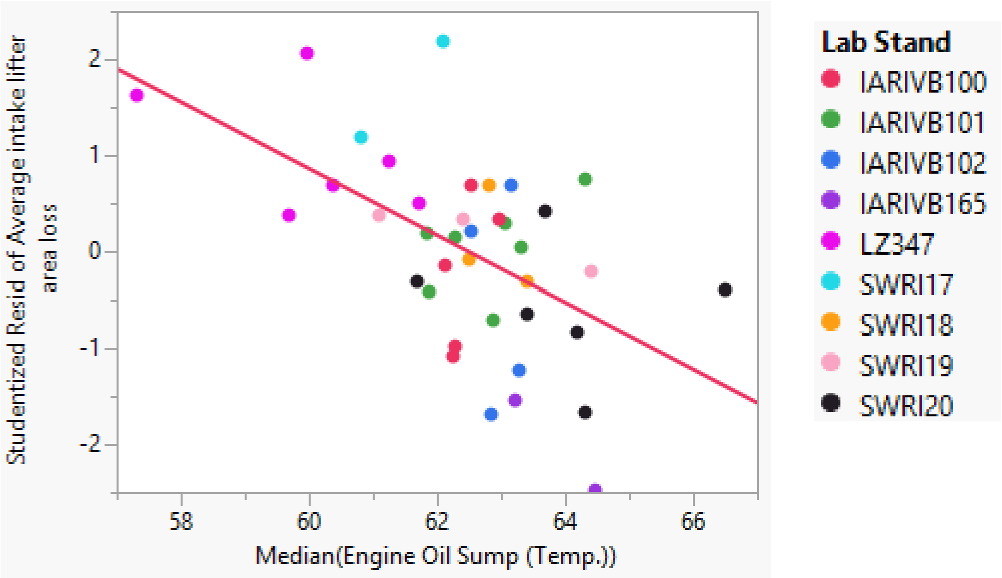
Possible **Stage 2 to Stage 1 Transition** Operational Differences Affecting Average Intake Lifter Area Loss

Lubrizol

Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

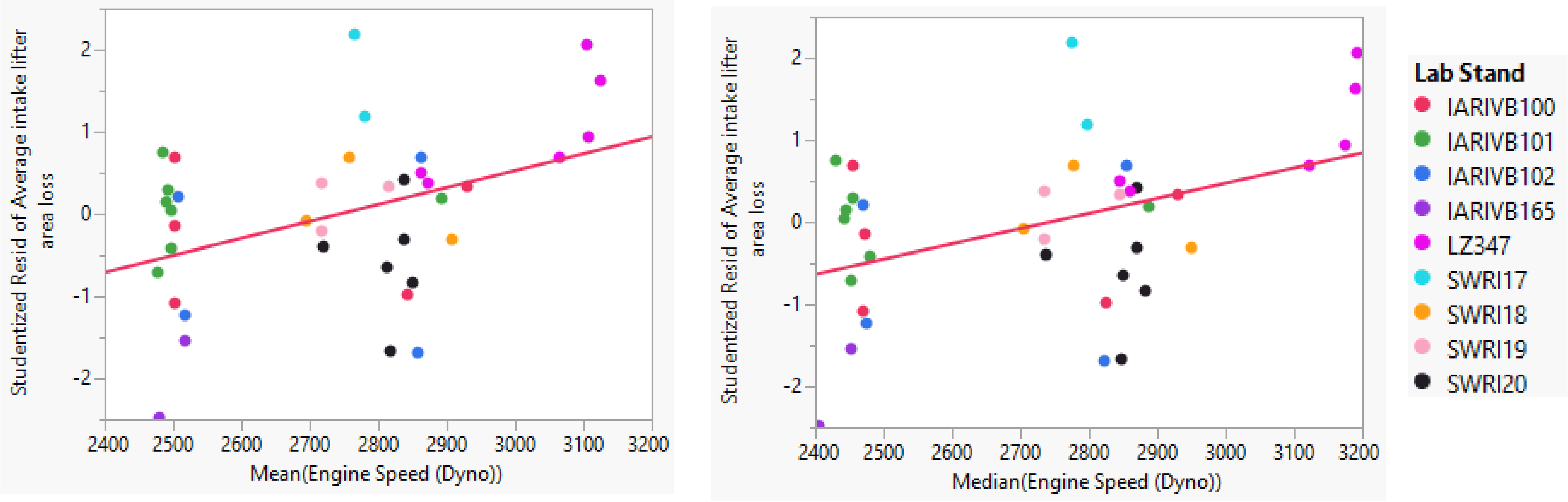
SUCCESS TOGETHER





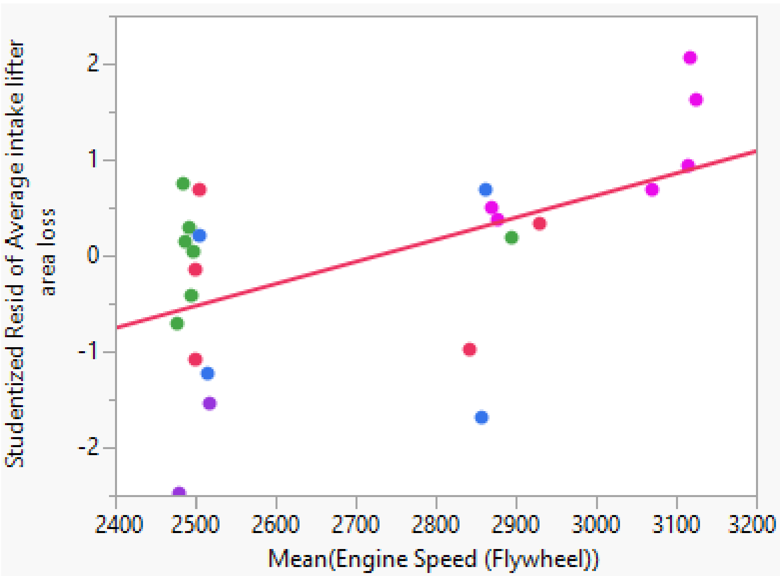
Lubrizol

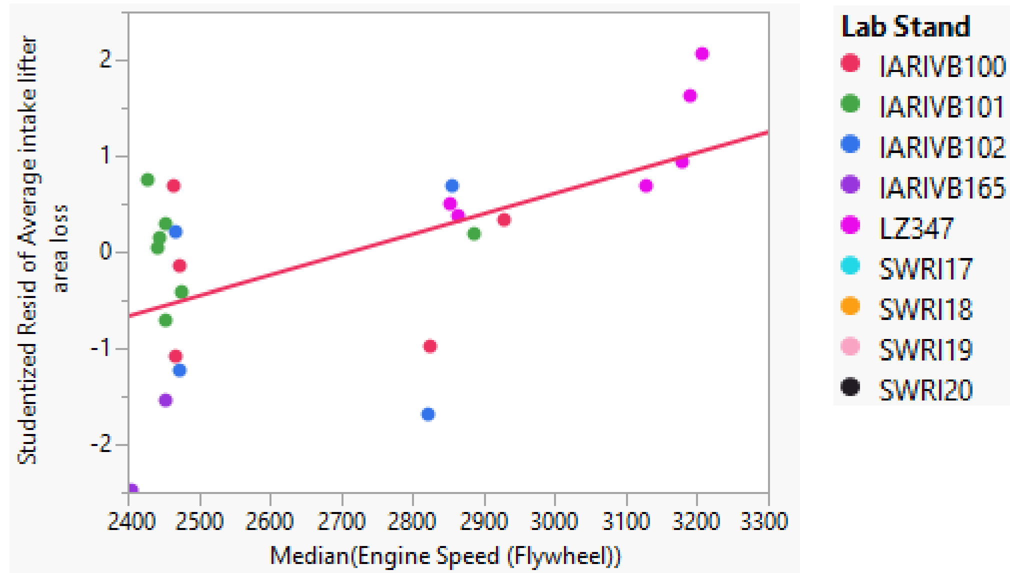
Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

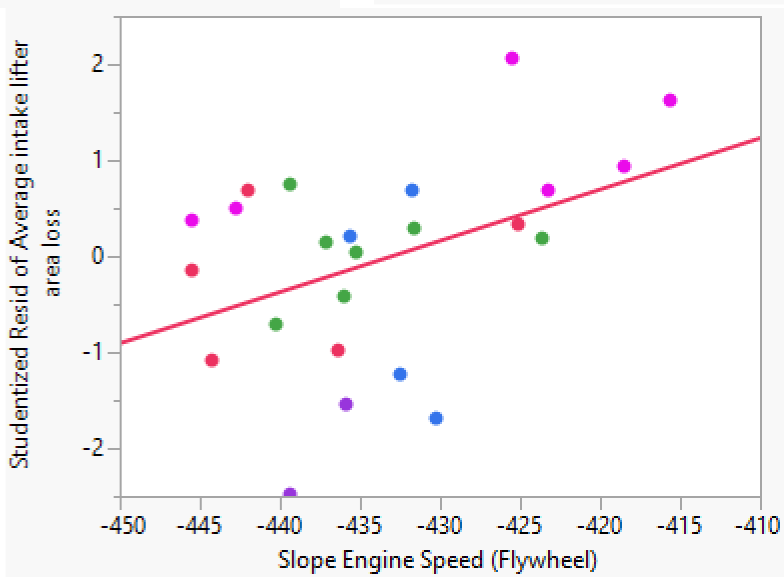


Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER

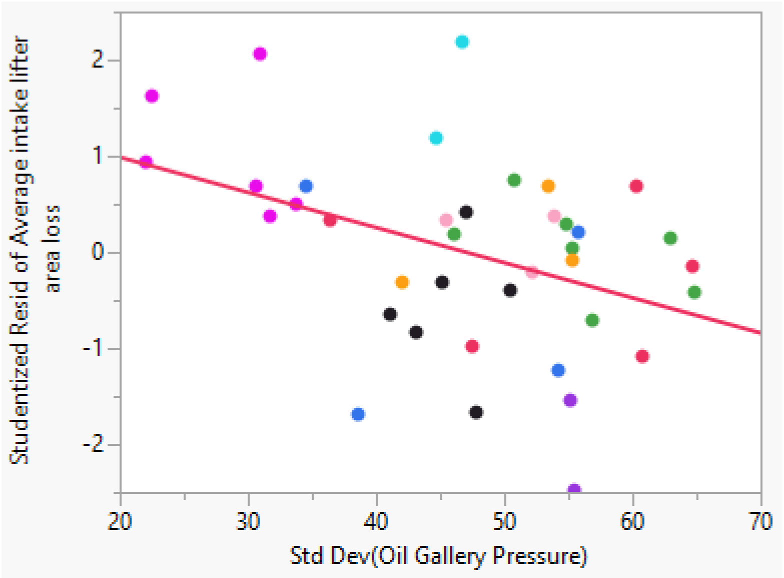


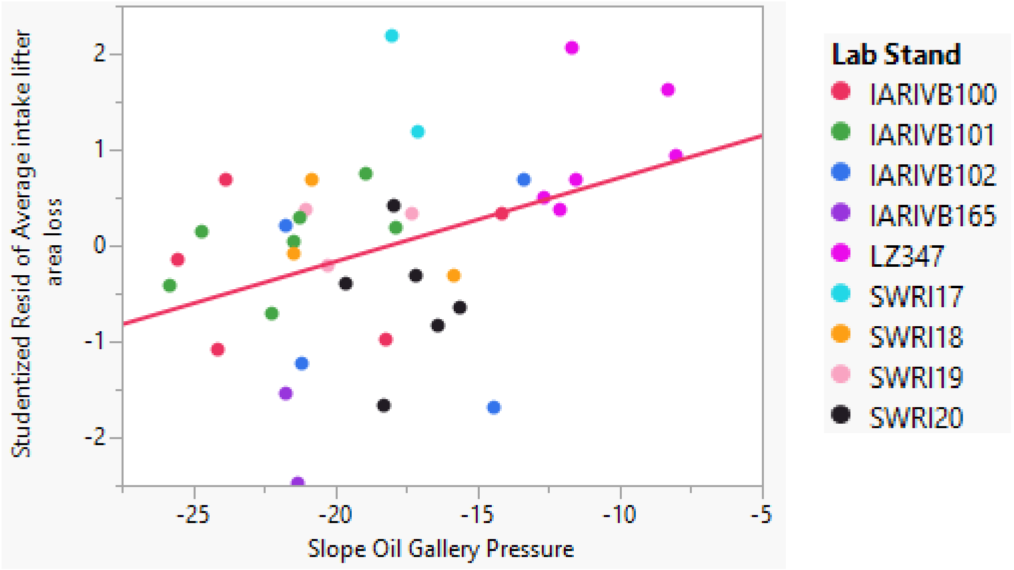




Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

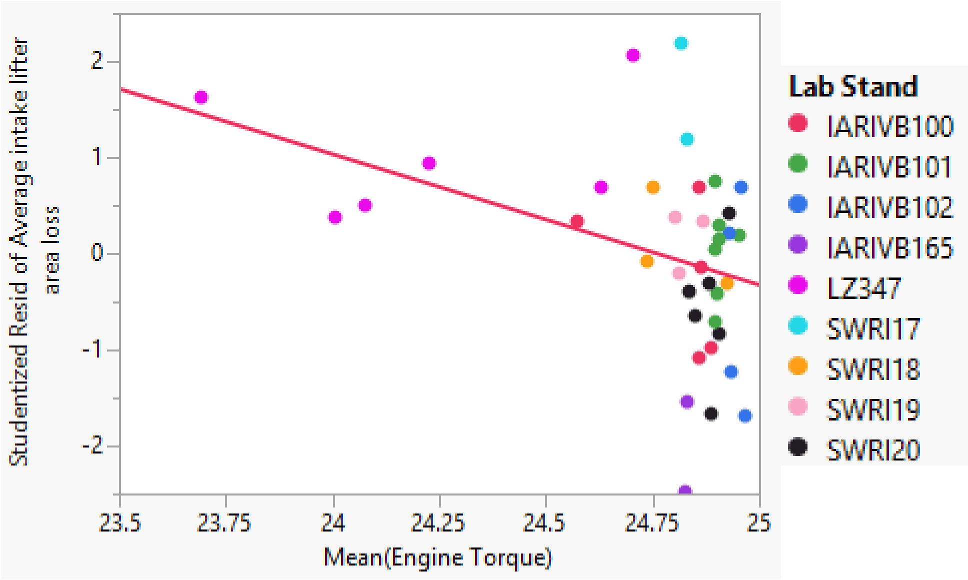
SUCCESS TOGETHER



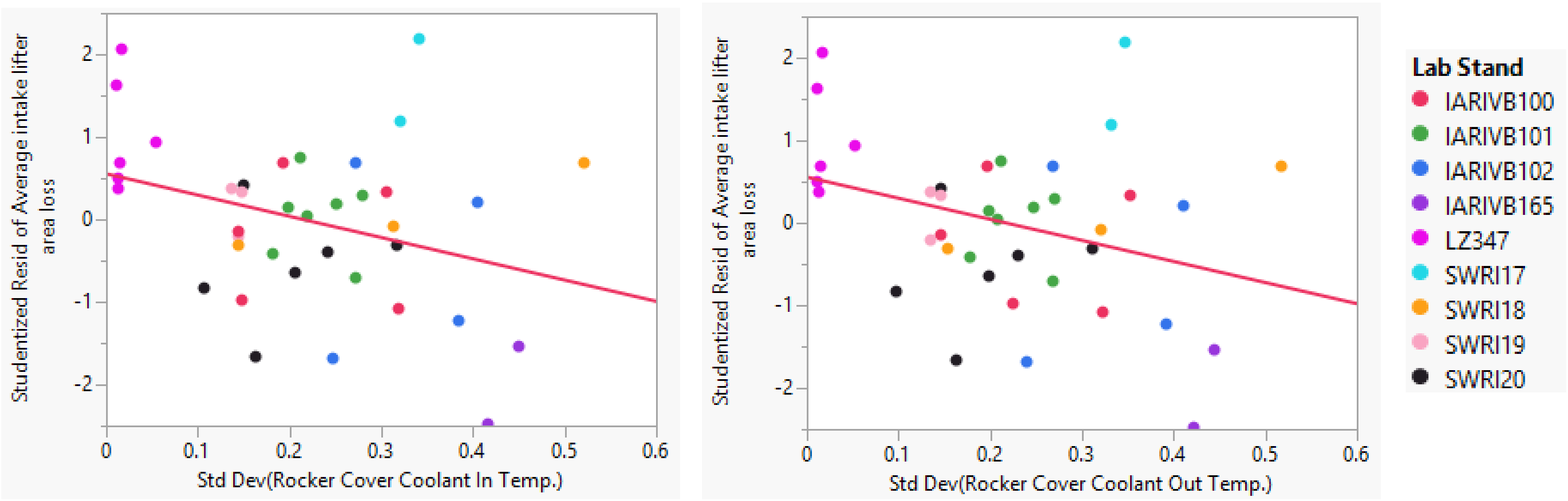


Lubrizol

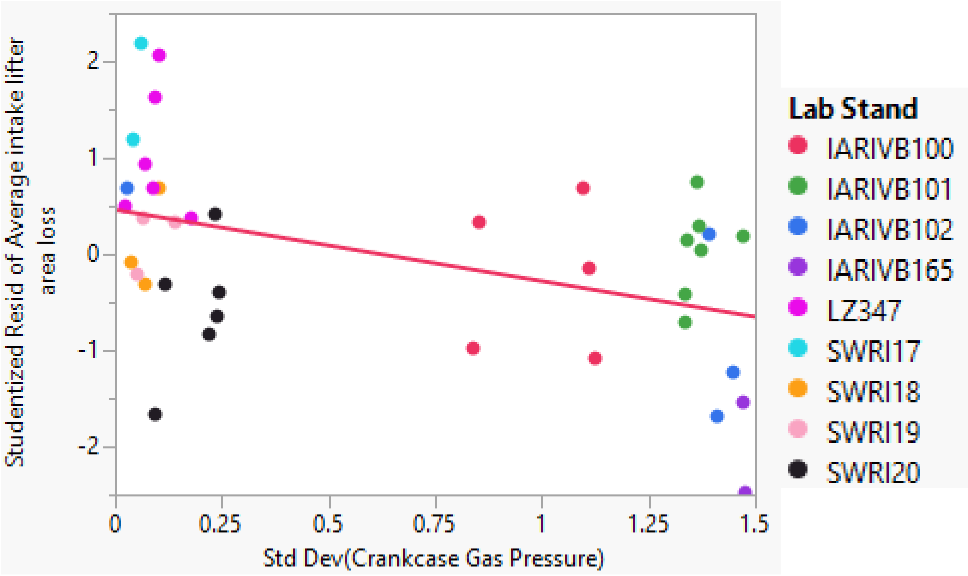
Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss



Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

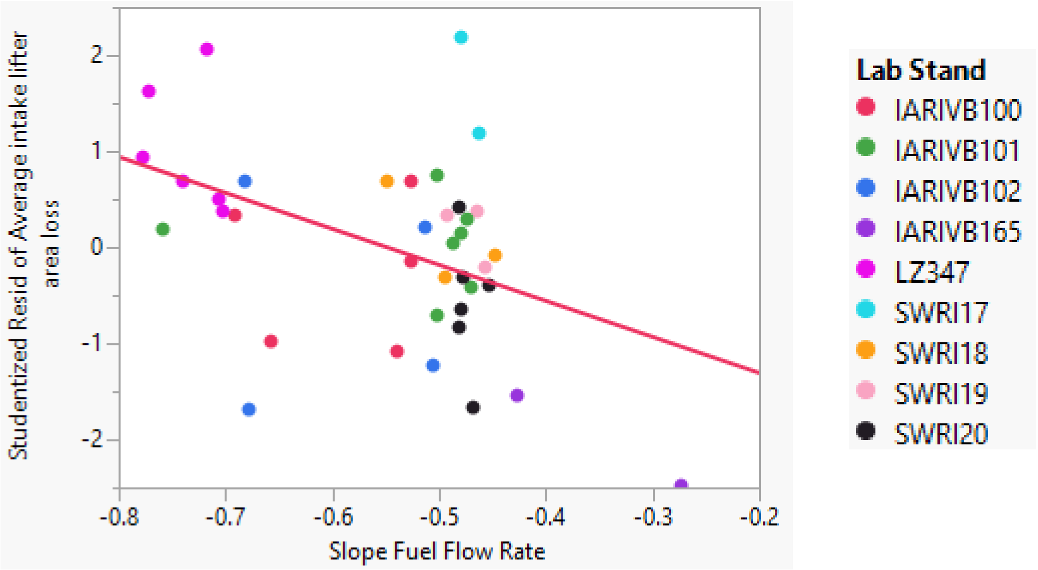


Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss



Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

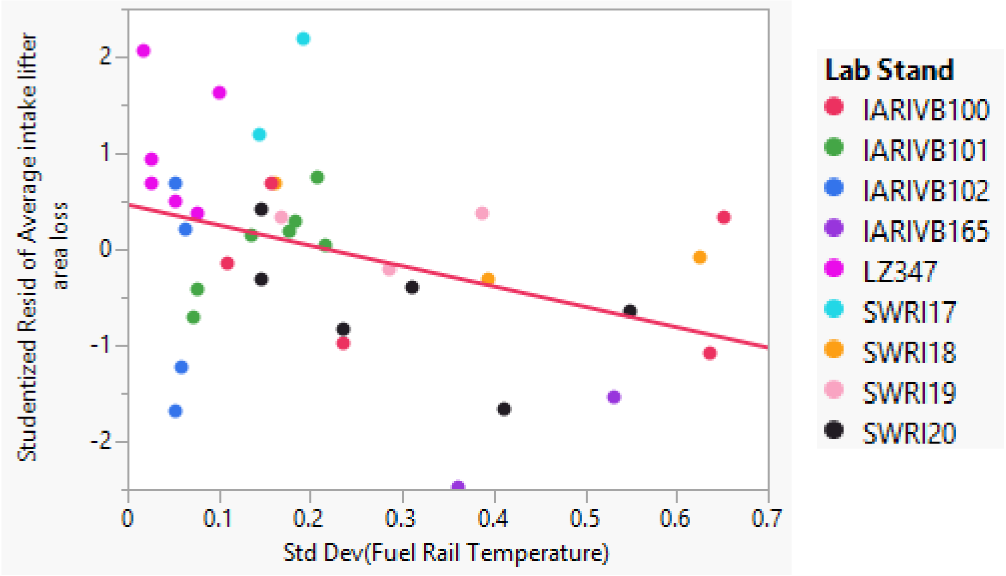
SUCCESS TOGETHER



Lubrizol

Possible Stage 2 to Stage 1 Operational Differences Affecting Average Intake Lifter Area Loss

SUCCESS TOGETHER



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Appendix C
Operational Data Plots

Operational Data

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- Operational data were collected from 101 to 102 hours of each test.
  - This contains 120 cycles (each cycle is 30 seconds)
  - Each cycle consists of 4 stages:
    - Stage 1 (7 seconds)
    - Stage 12: the transition from stage 1 to stage 2 (8 seconds)
    - Stage 2 (7 seconds)
    - Stage 21: the transition from stage 2 to stage 1 (8 seconds)
- Cycles of each test are overlaid on plots in this appendix
- On plots in which each test is shown in its own pane:
  - Tests are ordered by time within lab on the plots
  - Those in red are from earlier development work
  - Those in green represent the latest prove-out tests
- Erroneous data have been removed from the plots

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SUCCESS TOGETHER

Operational Data Plots
Controlled Parameters

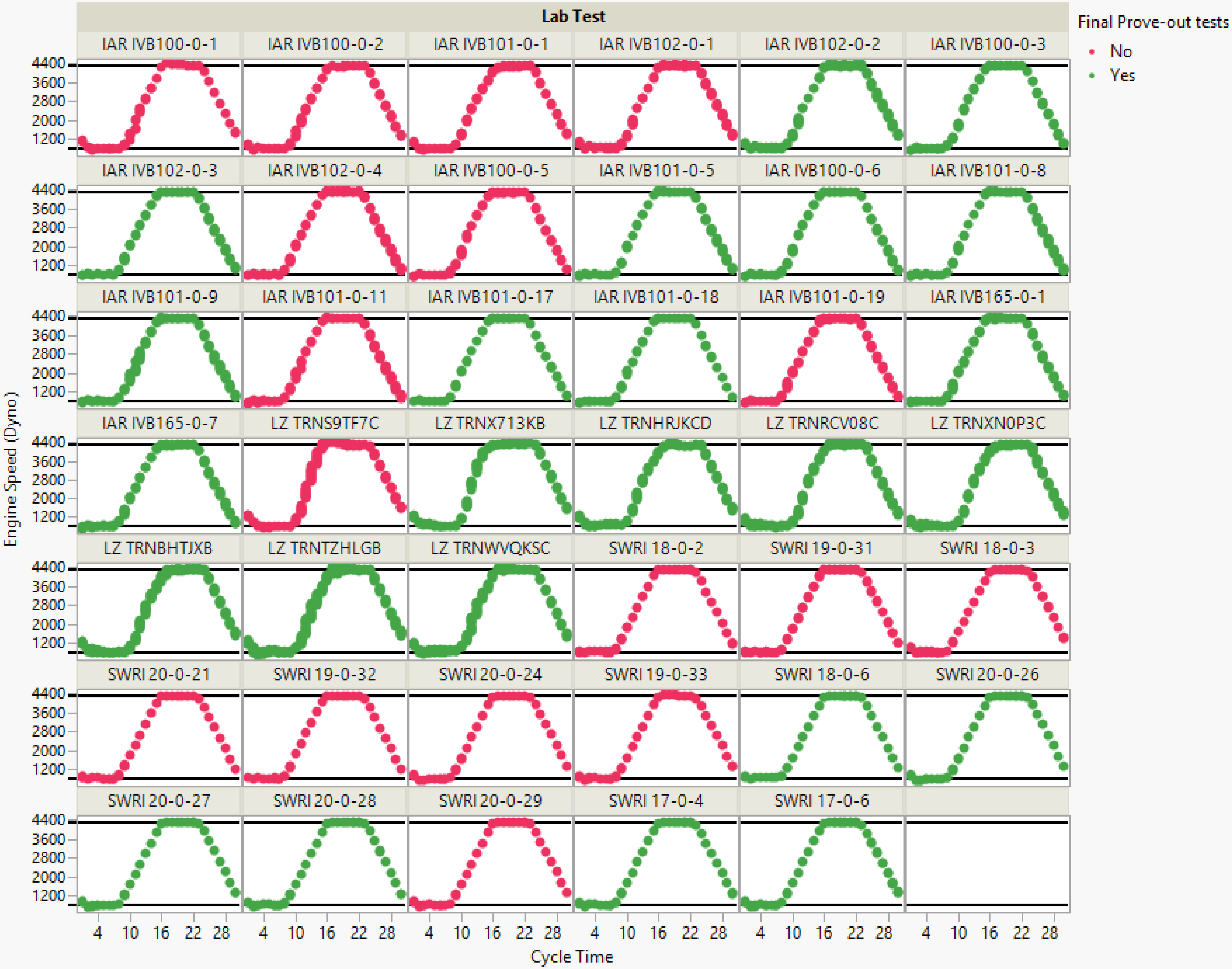
Lubrizol

Current Control Limits

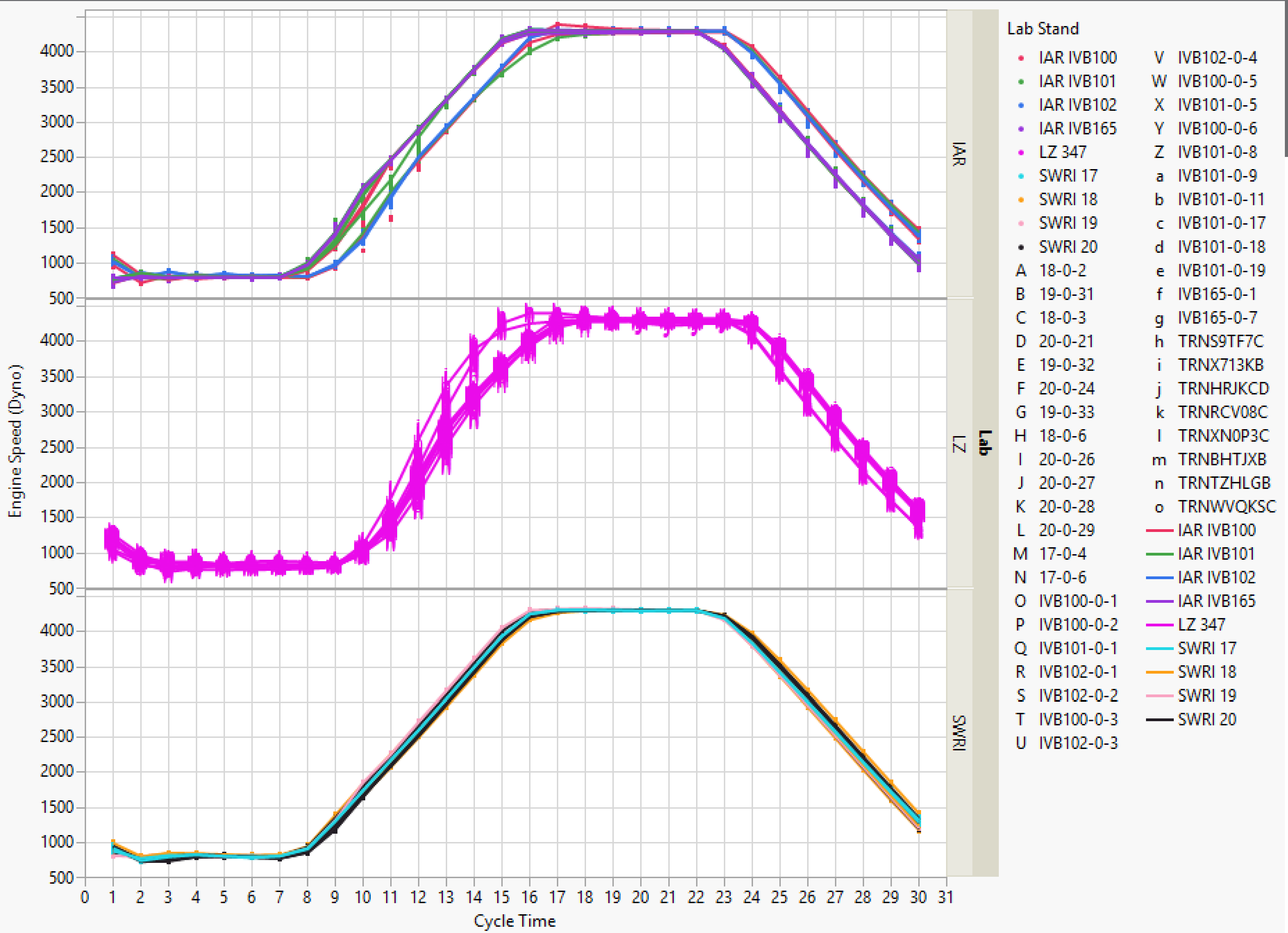
SUCCESS TOGETHER

Sequence IVB - Test Sequence					
Parameter	Units	Ramp to Stage 1	Stage 1	Ramp to Stage 2	Stage 2
Duration	s	8	7	8	7
Engine Speed	rpm	4300 to 800	800 ± 25	800 to 4300	4300 ± 25
Engine Torque	N-m	25 ± 2	25 ± 2	25 ± 2	25 ± 2
Coolant Temperature Into Engine	°C	49 ± 3	49 ± 3	49 ± 3	49 ± 3
Coolant Delta Temperature	°C	5 to 2	2 ± 1	2 to 5	5 ± 1
Engine Oil Gallery Temperature	°C	55 to 53	53 ± 3	53 to 55	55 ± 3
Intake Air Temperature	°C	32 ± 3	32 ± 3	32 ± 3	32 ± 3
Rocker Cover Coolant Out Temperature	°C	20 ± 2	20 ± 2	20 ± 2	20 ± 2
Fuel Rail Temperature	°C	24 ± 3	24 ± 3	24 ± 3	24 ± 3
Load Cell Temperature	°C	45 ± 3	45 ± 3	45 ± 3	45 ± 3
Intake Air Pressure	kPa	0.07 ± 0.07	0.07 ± 0.07	0.07 ± 0.07	0.07 ± 0.07
Intake Air Humidity	g/kg	11.5 ± 0.5	11.5 ± 0.5	11.5 ± 0.5	11.5 ± 0.5
Exhaust Pressure	kPa(a)	104.5 to 103.5	103.5 ± 1	103.5 to 104.5	104.5 ± 1
Engine Coolant Pressure	kPa	70 ± 10	70 ± 10	70 ± 10	70 ± 10
Fuel Rail Pressure	kPa	335 ± 10	335 ± 10	335 ± 10	335 ± 10
Air Fuel Ratio	AFR	record	14.5 ± 0.5	record	14.5 ± 0.5

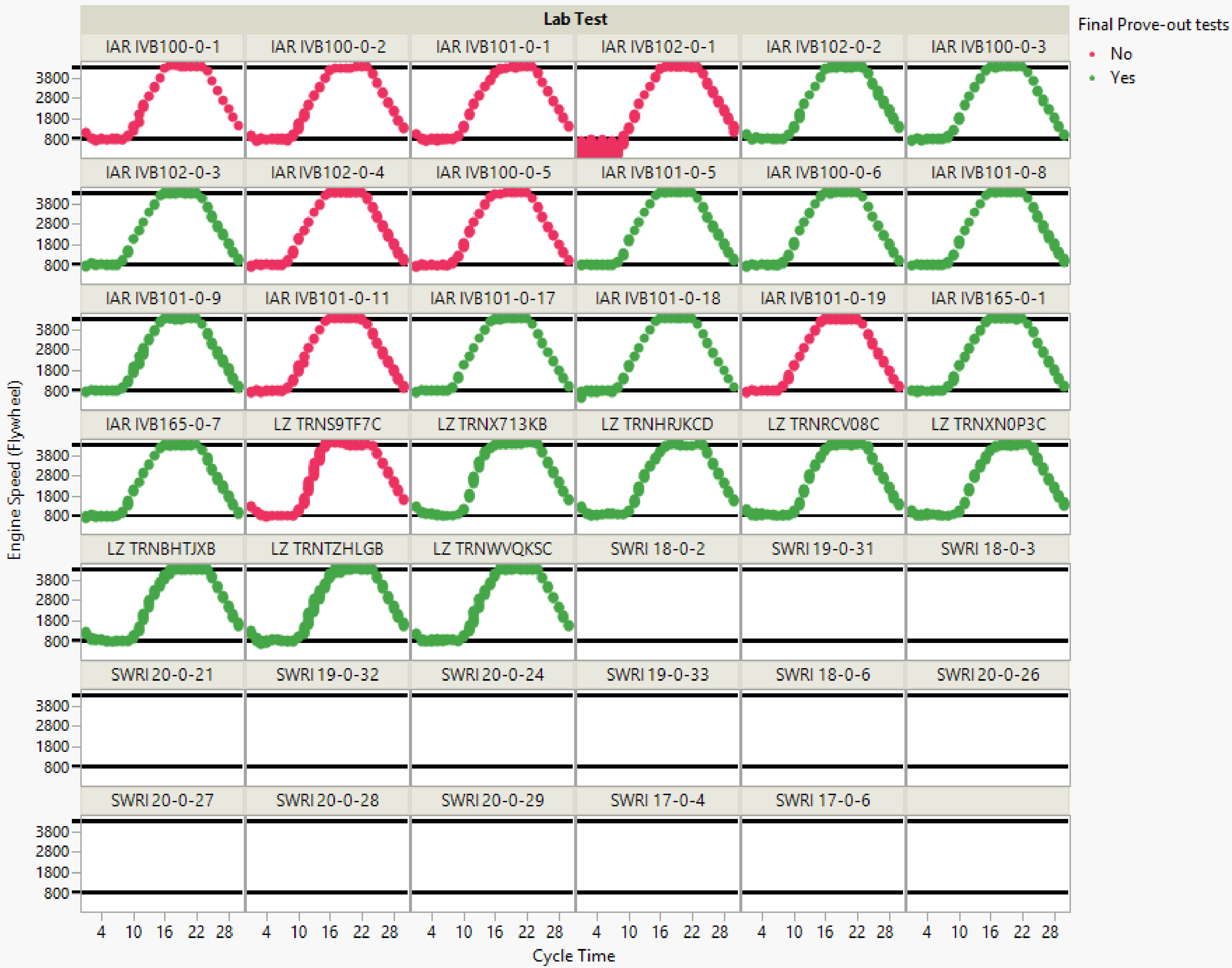
Lubrizol



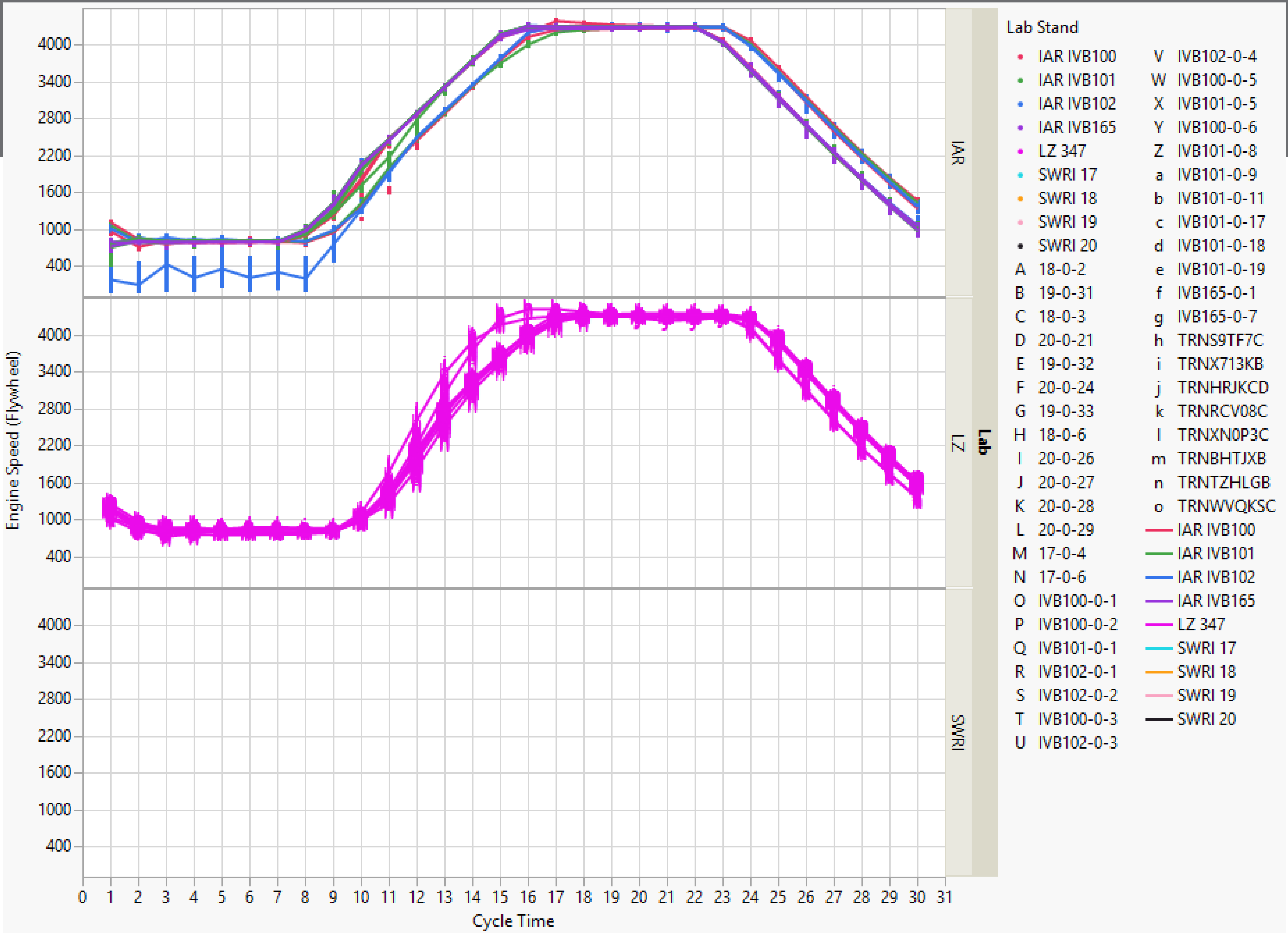
Lab Test
Final Prove-out tests
No
Yes
Engine Speed (Dyno)
Cycle Time
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
4400
3600
2800
2000
1200
4
10
16
22
28



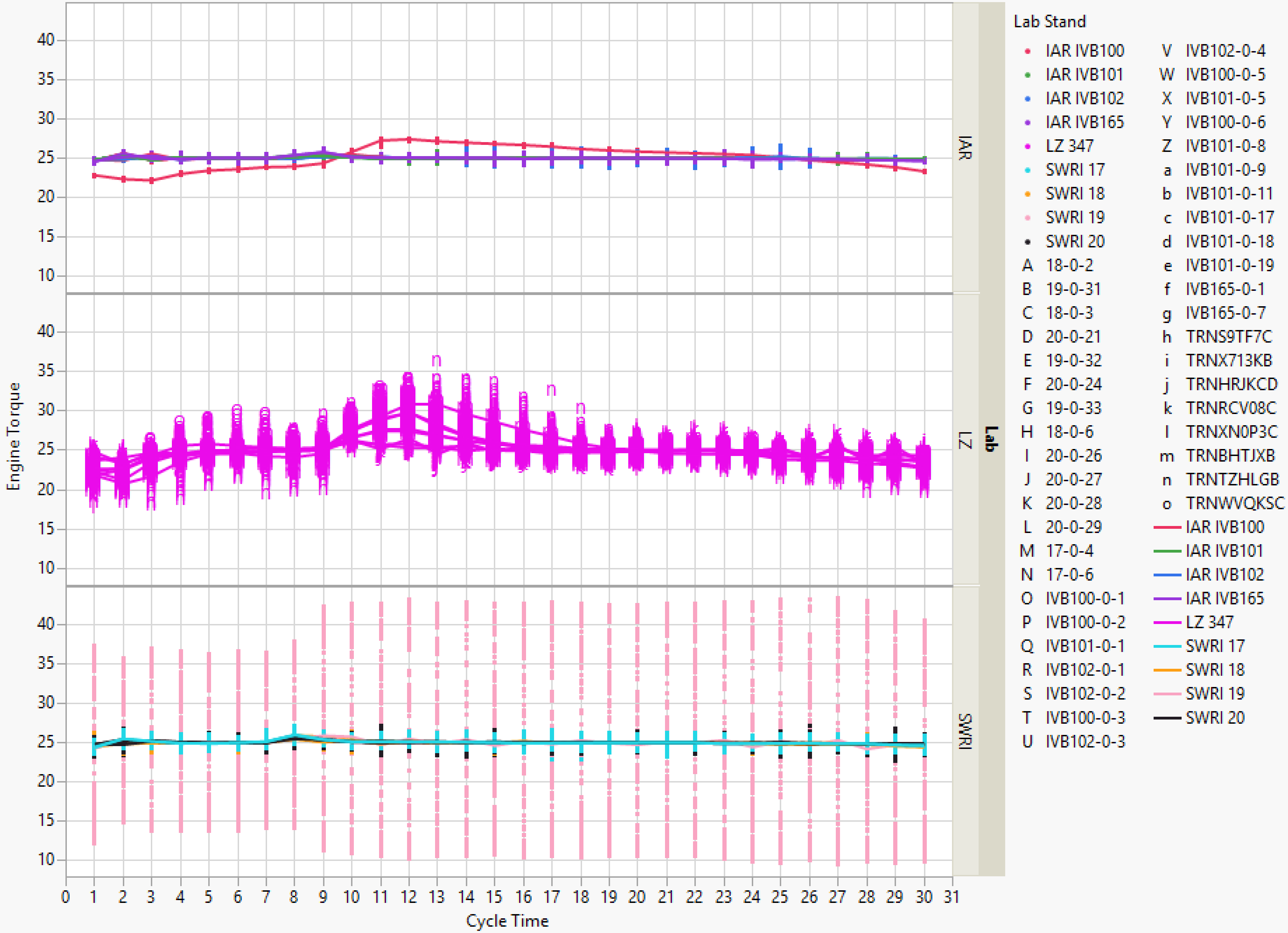
Engine Speed (Dyno)
Cycle Time
Lab
IAR
LZ
SWRI
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC

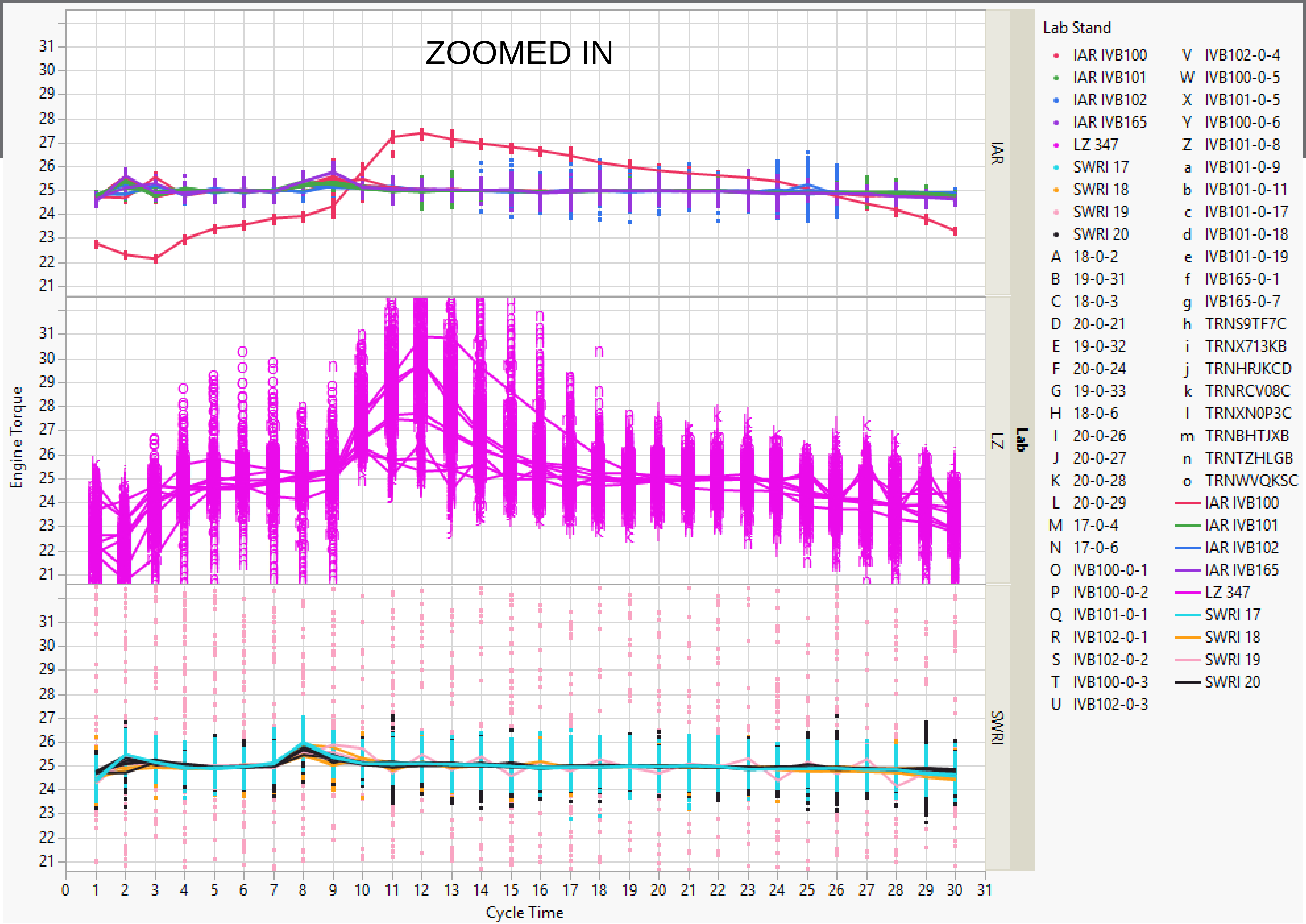


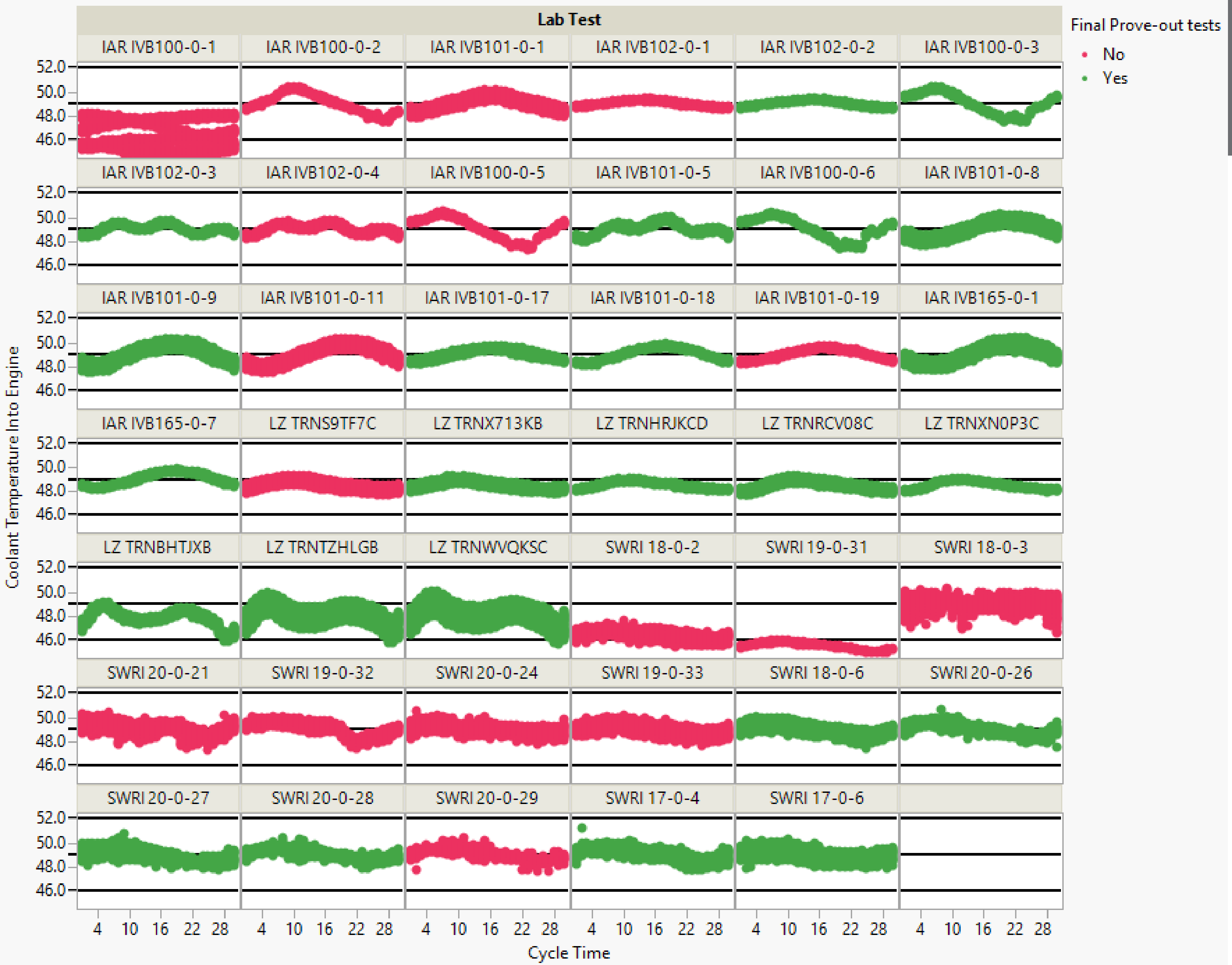
Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Engine Speed (Flywheel)
3800
2800
1800
800
4
10
16
22
28
Cycle Time


Engine Speed (Flywheel)
Cycle Time
Lab
IAR
LZ
SWRI
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

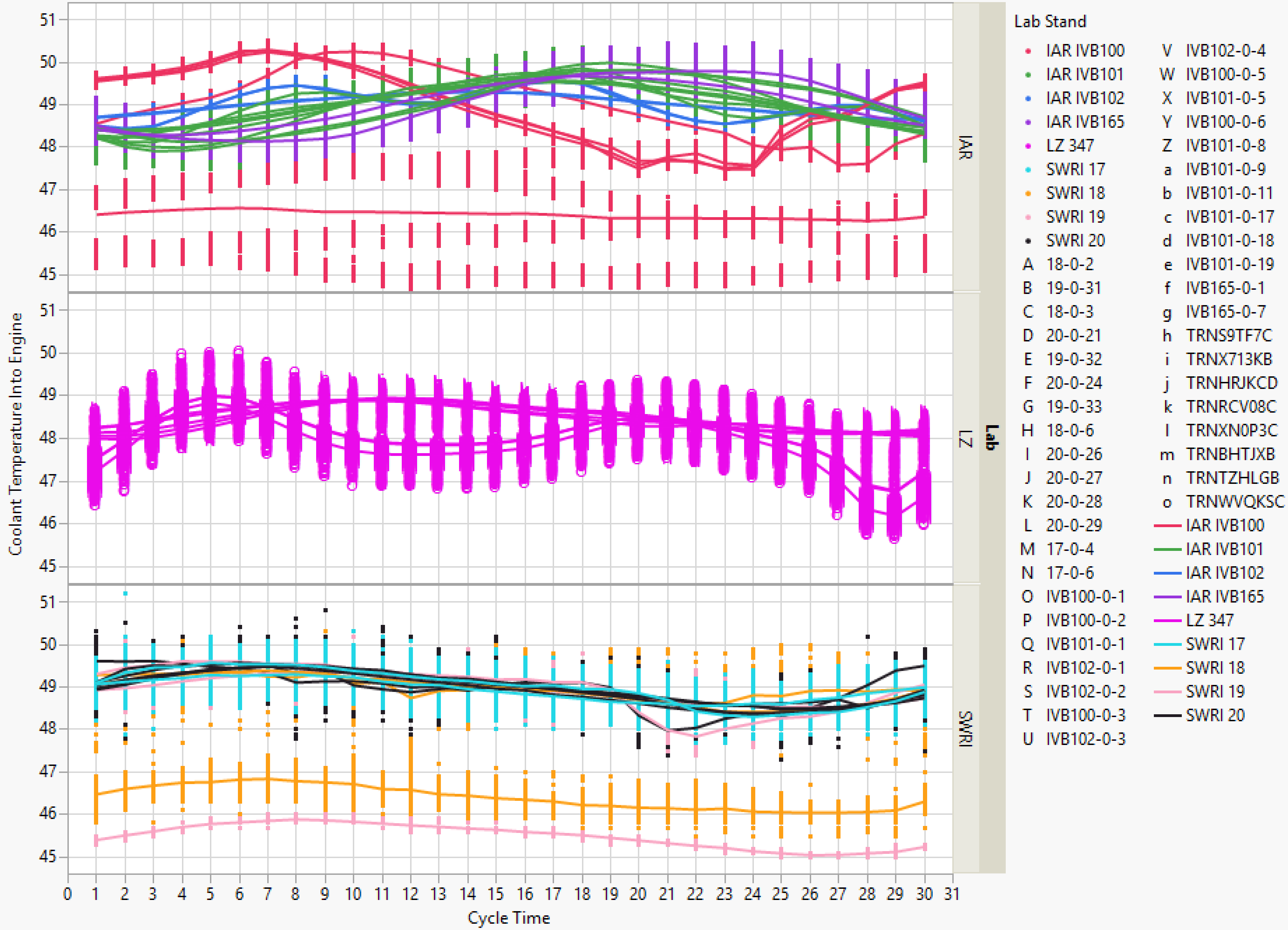
Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Engine Torque
38
30
22
14
4
10
16
22
28
Cycle Time

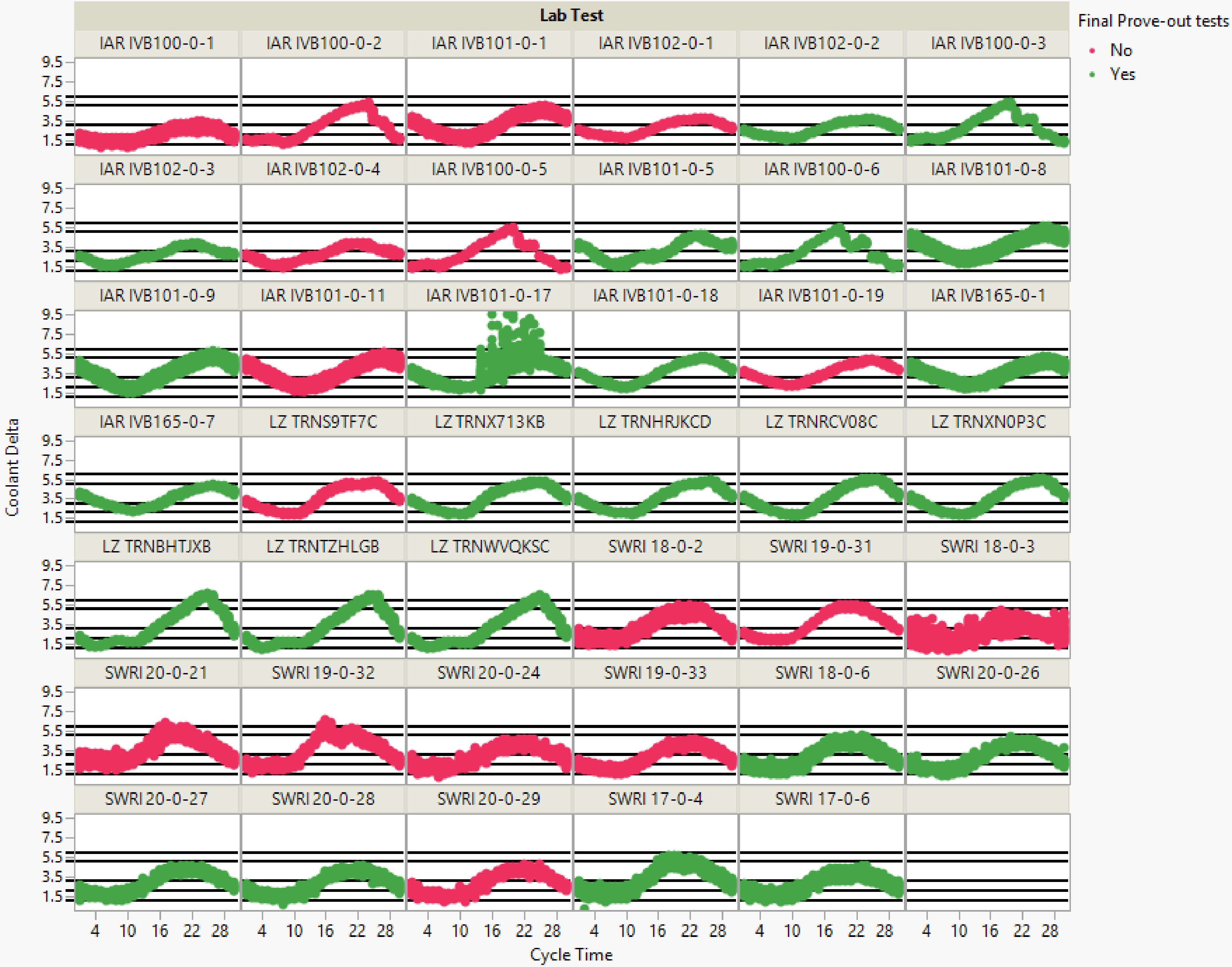

Engine Torque
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


ZOOMED IN
Engine Torque
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC

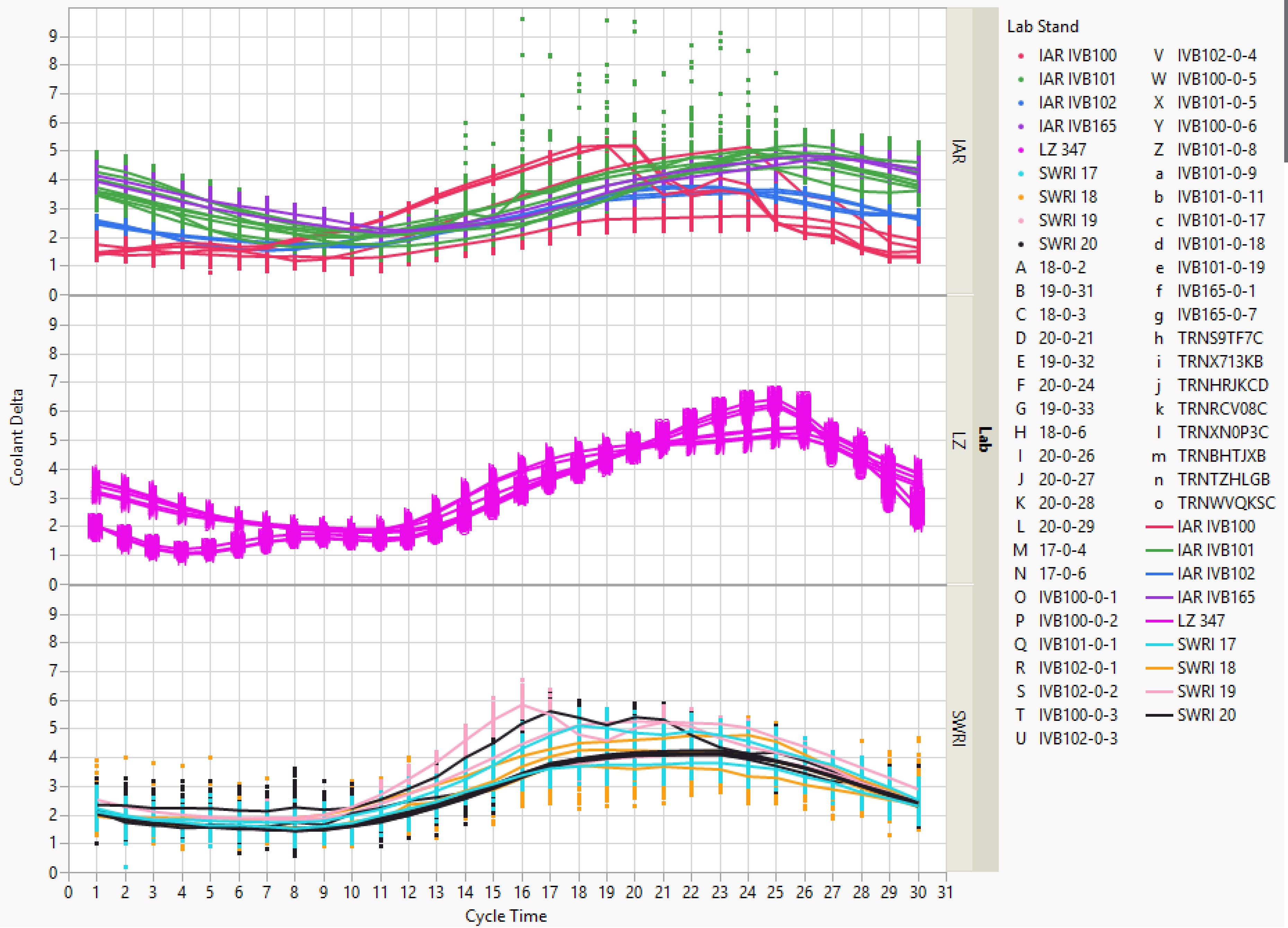


Lab Test
Final Prove-out tests
No
Yes
Coolant Temperature Into Engine
Cycle Time
52.0
50.0
48.0
46.0
4
10
16
22
28
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6

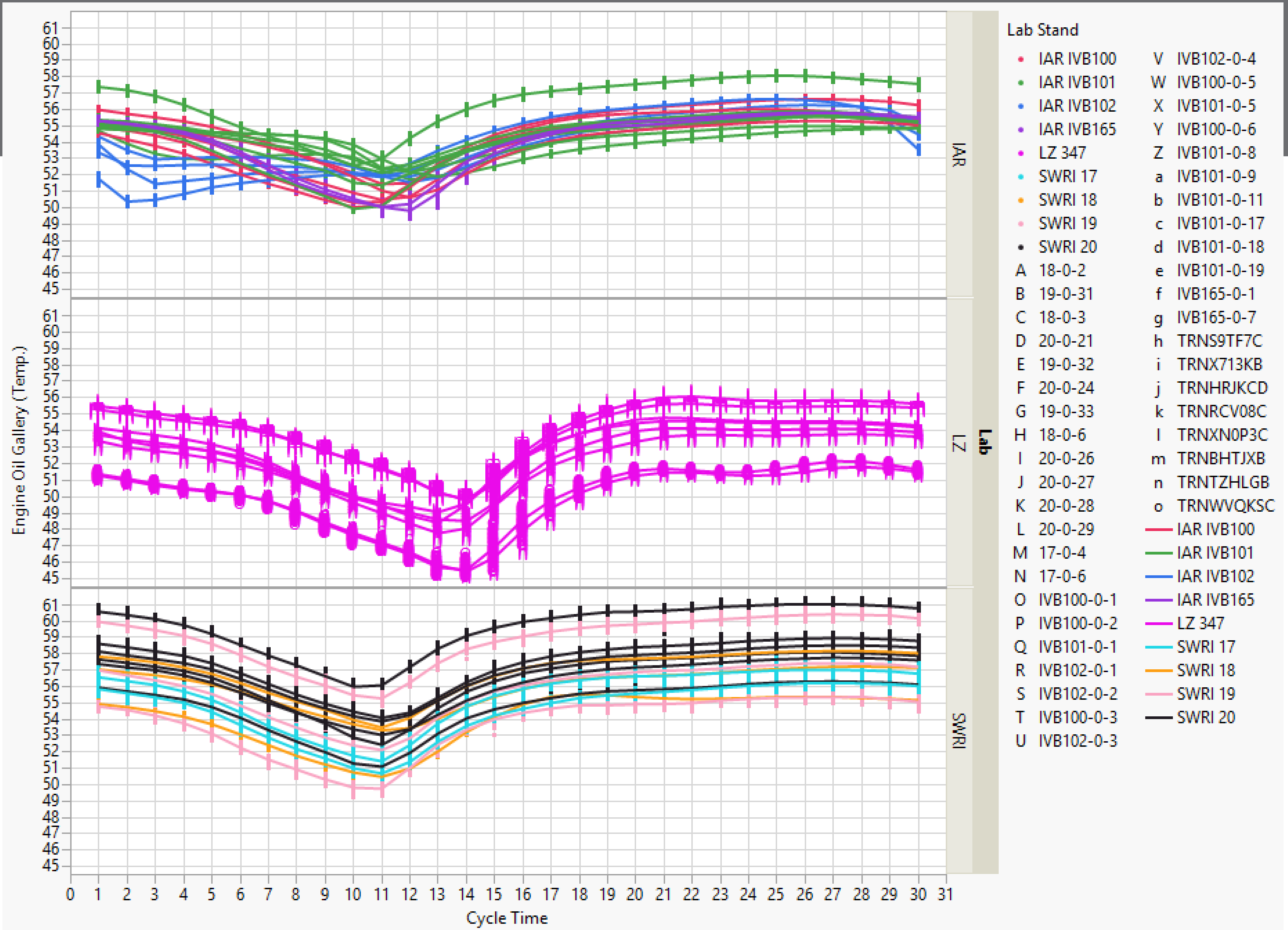

Coolant Temperature Into Engine
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC



Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Coolant Delta
9.5
7.5
5.5
3.5
1.5
4
10
16
22
28
Cycle Time

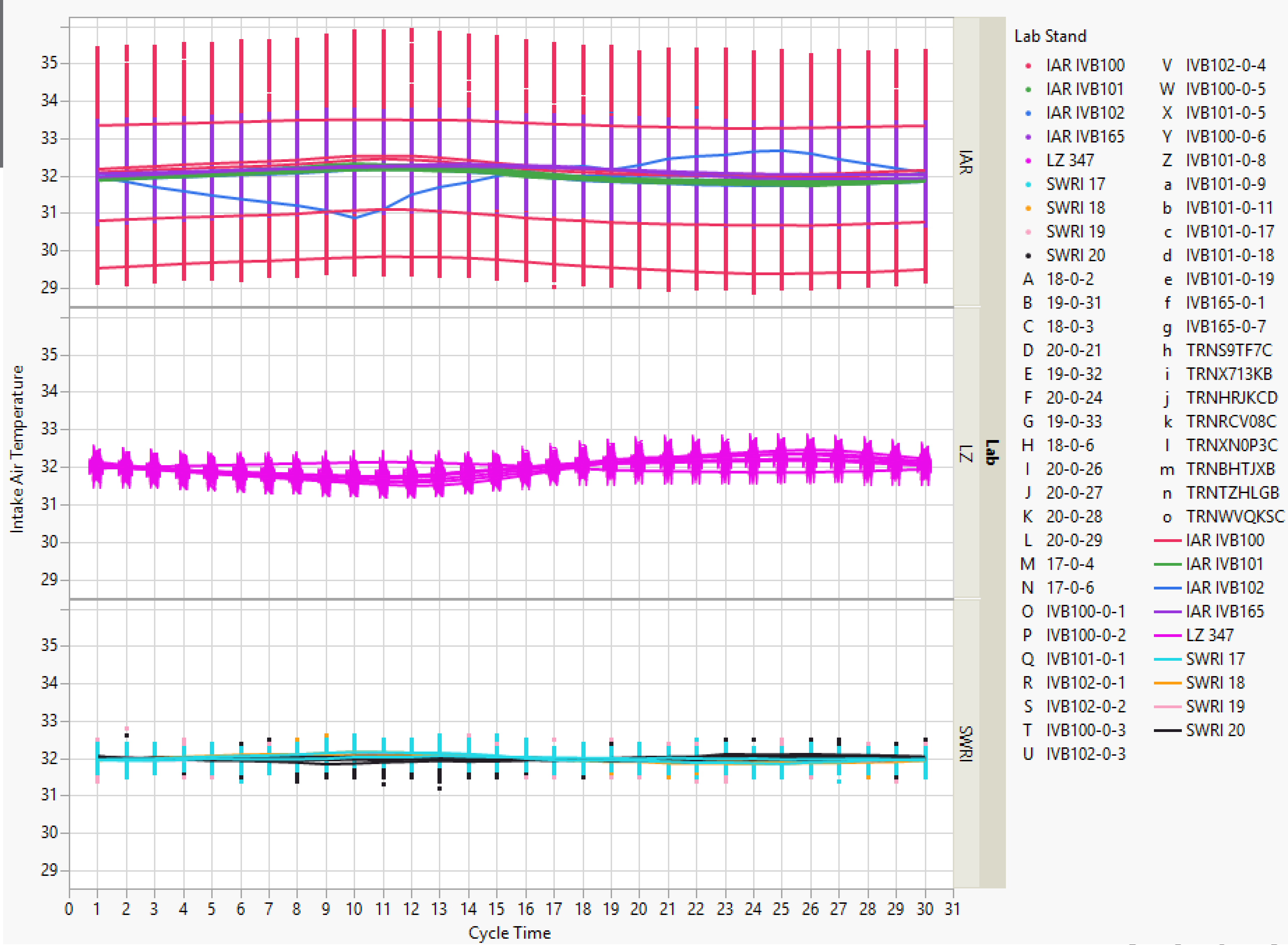

Coolant Delta
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Engine Oil Gallery (Temp.)
60
56
52
48
4
10
16
22
28
Cycle Time


Engine Oil Gallery (Temp.)
IAR
LZ
SWRI
Lab
Cycle Time
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

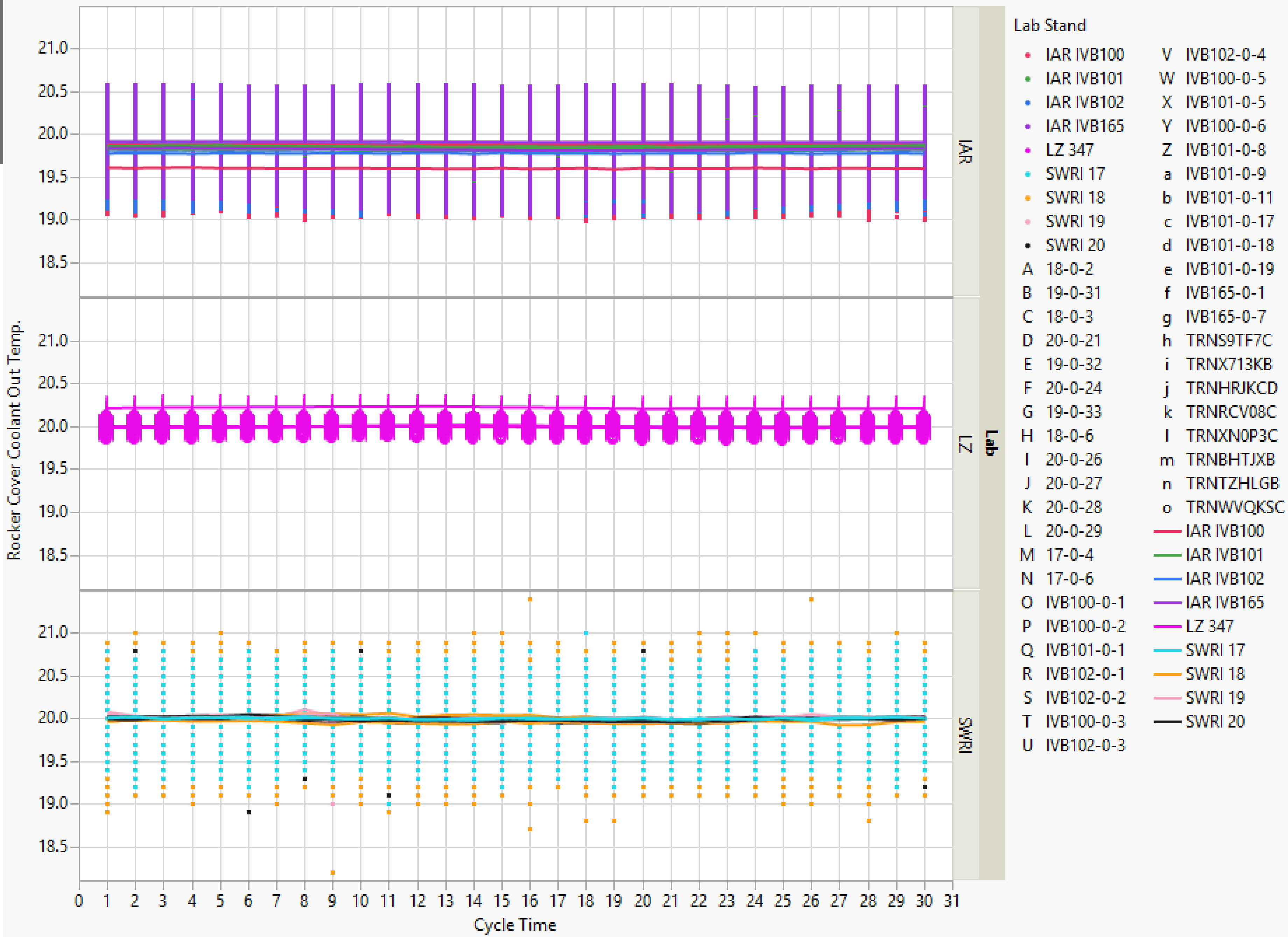
Lubrizol

Lab Test
Final Prove-out tests
No
Yes
Intake Air Temperature
Cycle Time
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
36.0
34.0
32.0
30.0
4
10
16
22
28



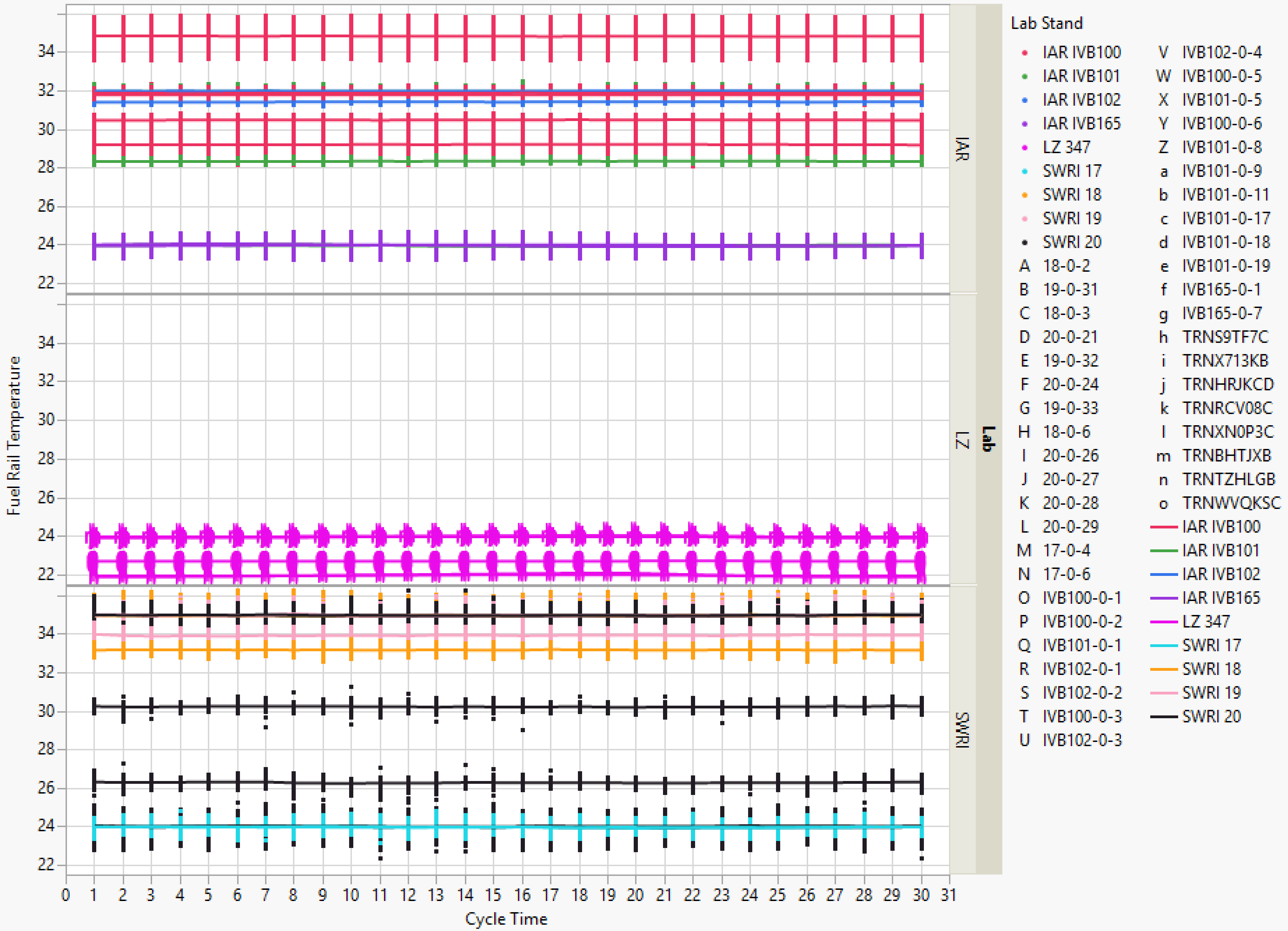
Intake Air Temperature
35
34
33
32
31
30
29
IAR
LZ
SWRI
Lab
Cycle Time
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Rocker Cover Coolant Out Temp.
21.5
20.0
18.5
4
10
16
22
28
Cycle Time



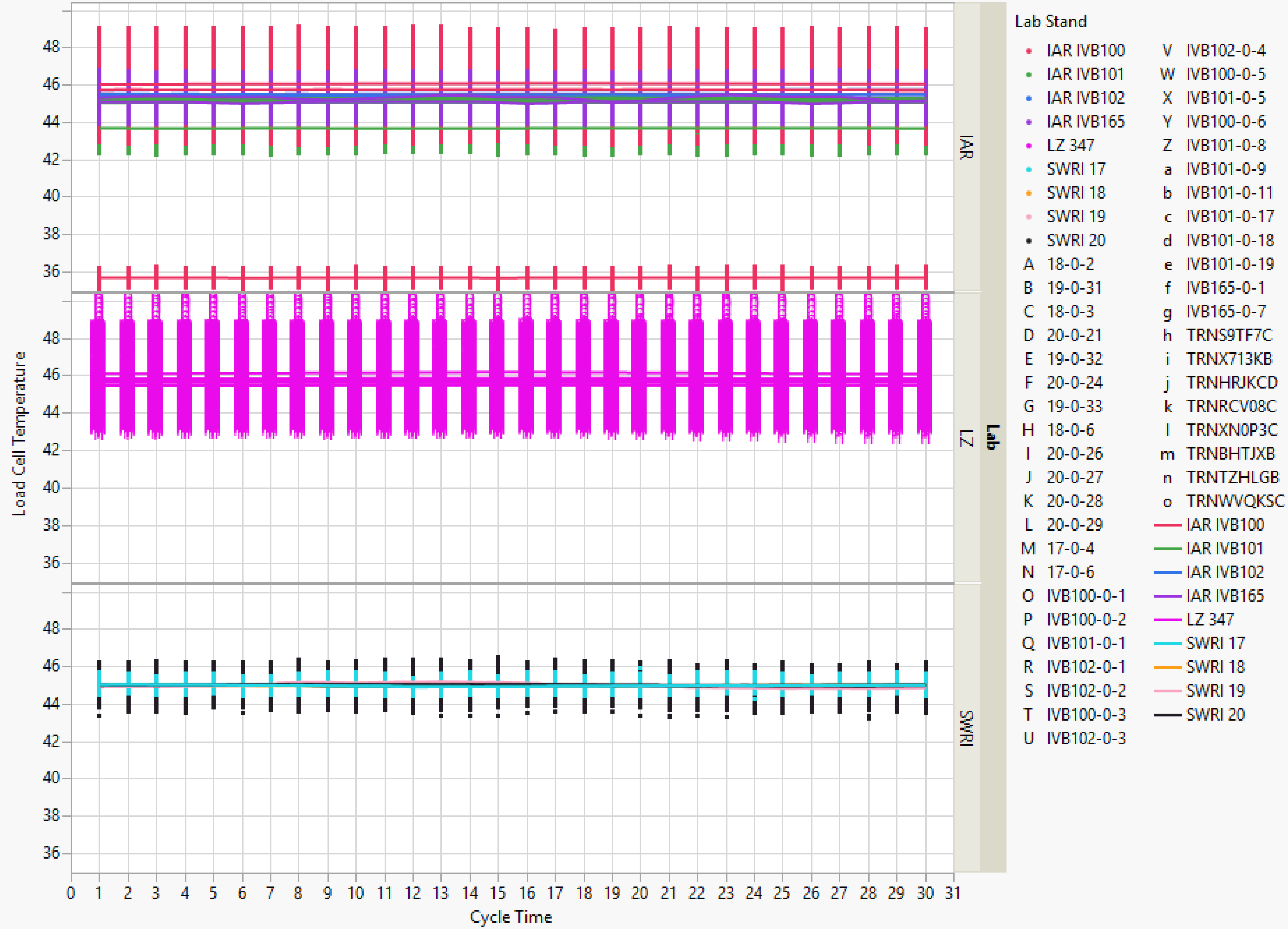
Rocker Cover Coolant Out Temp.
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


Lab Test
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Final Prove-out tests
No
Yes
Fuel Rail Temperature
34
30
26
22
Cycle Time
4
10
16
22
28

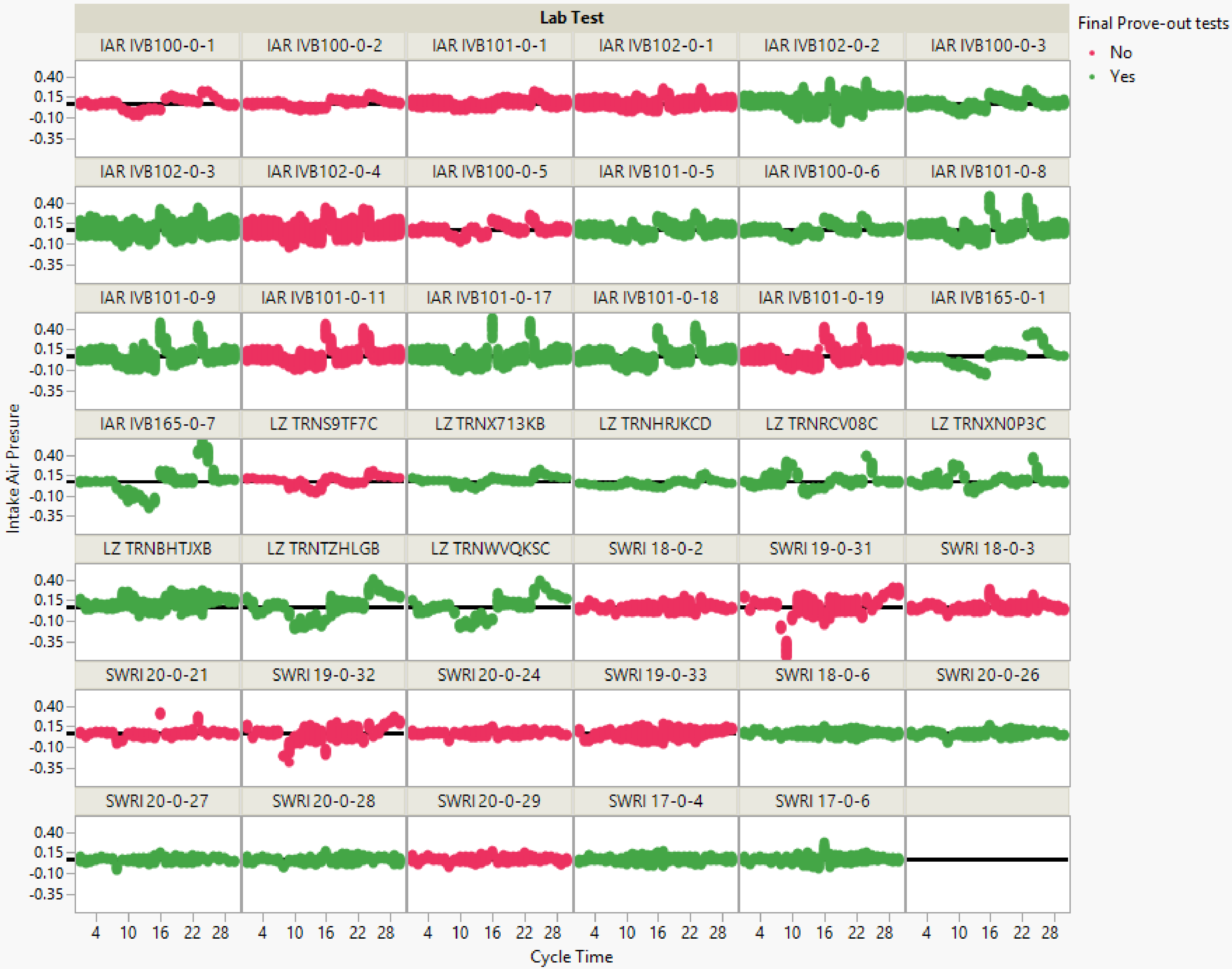


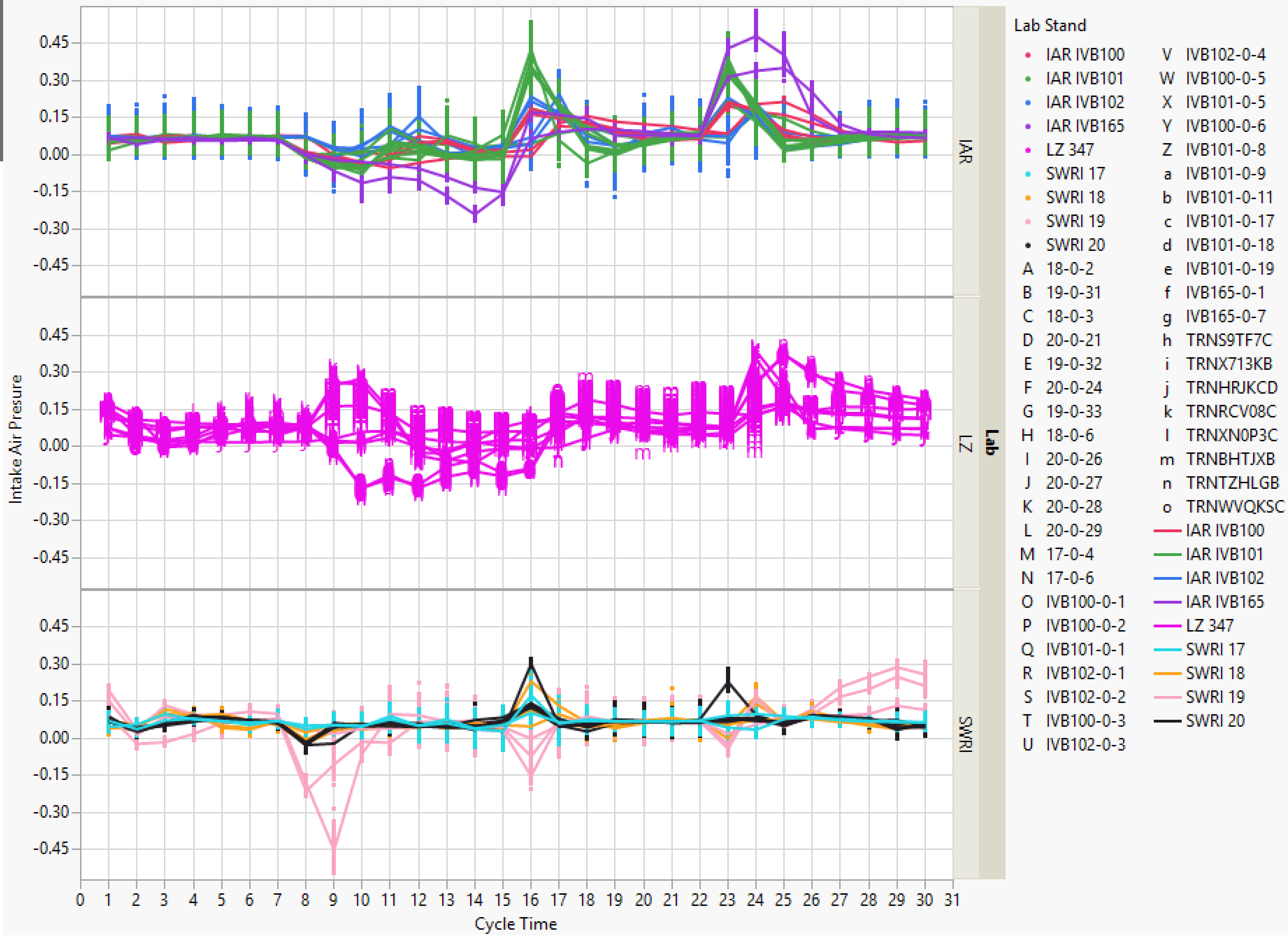
Fuel Rail Temperature
Cycle Time
Lab
IAR
LZ
SWRI
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Load Cell Temperature
50
46
42
38
4
10
16
22
28
Cycle Time

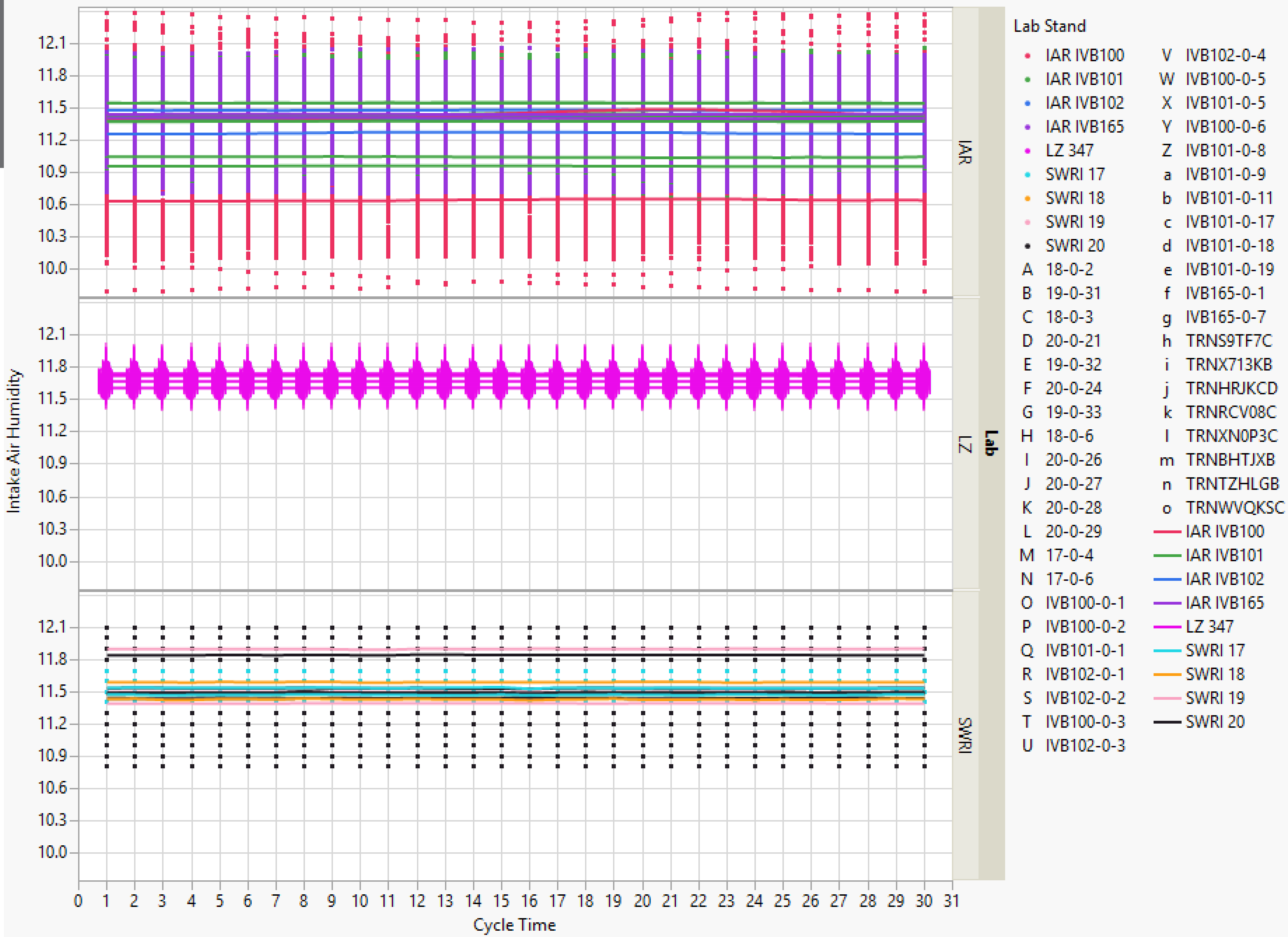


Load Cell Temperature
48
46
44
42
40
38
36
IAR
LZ
SWRI
Lab
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Cycle Time
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Intake Air Presure
0.40
0.15
-0.10
-0.35
4
10
16
22
28
Cycle Time

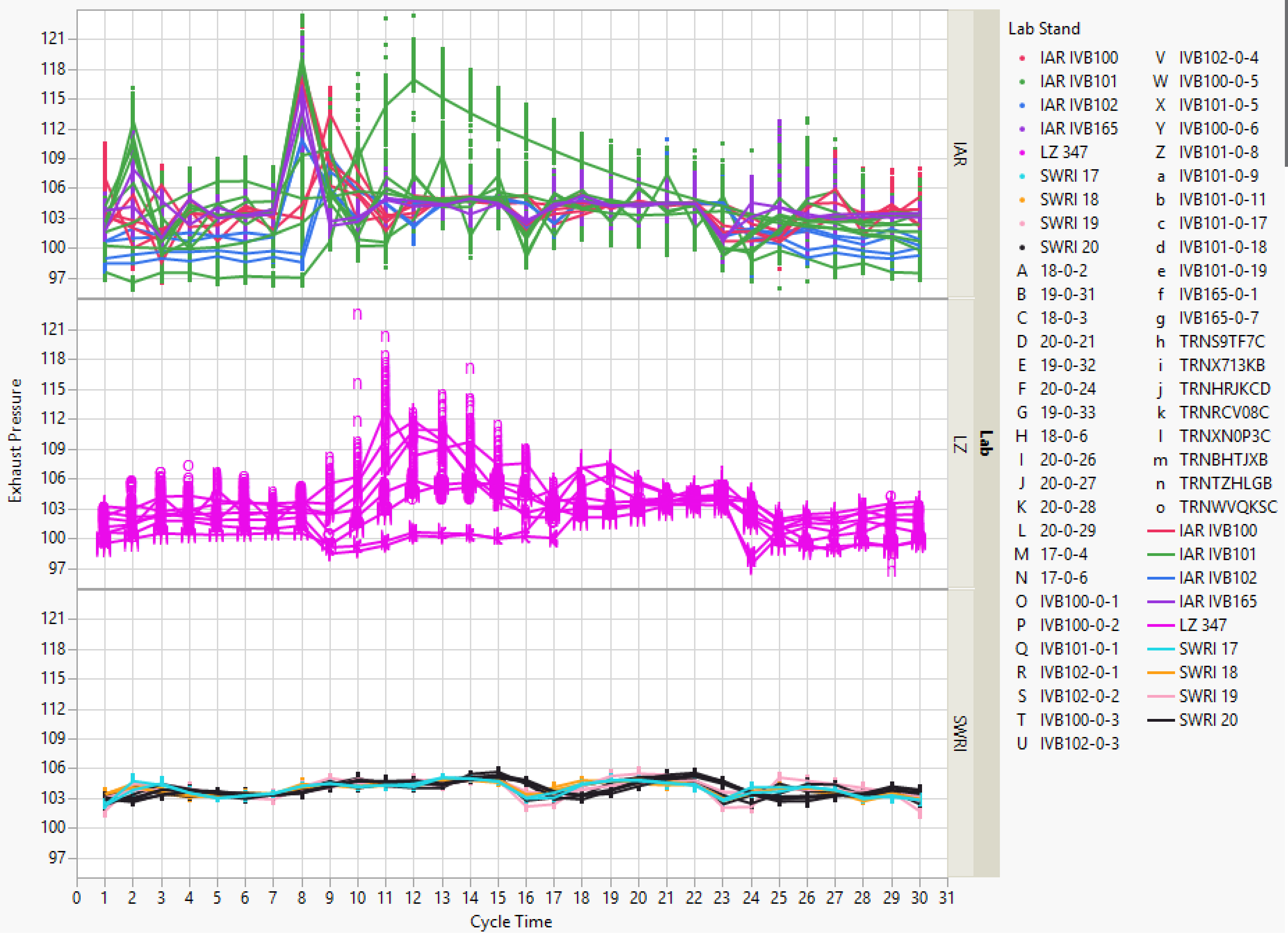

Intake Air Presure
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Intake Air Humidity
12.2
11.7
11.2
10.7
10.2
4
10
16
22
28
Cycle Time

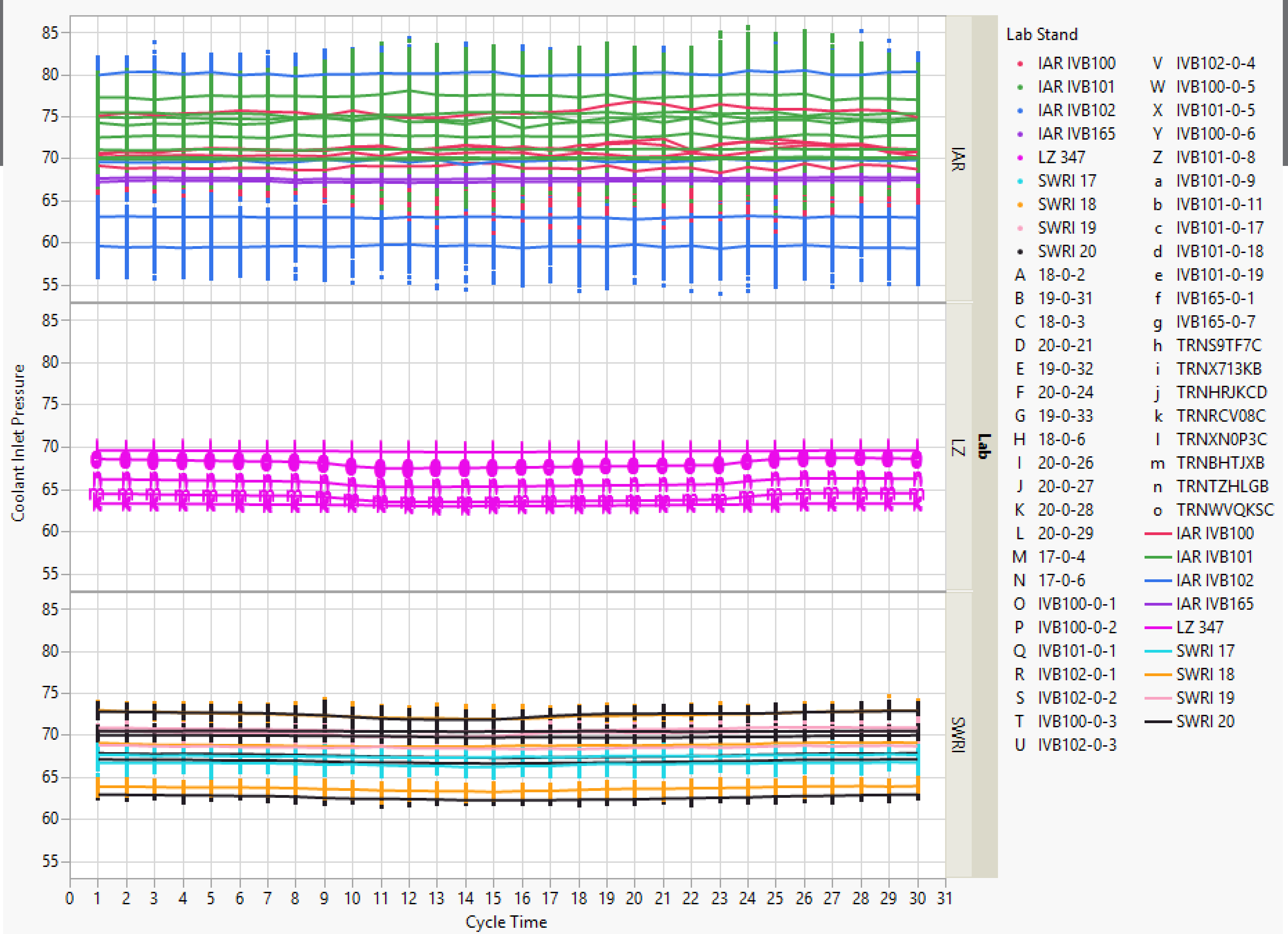


Intake Air Humidity
12.1
11.8
11.5
11.2
10.9
10.6
10.3
10.0
IAR
LZ
SWRI
Lab
Cycle Time
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

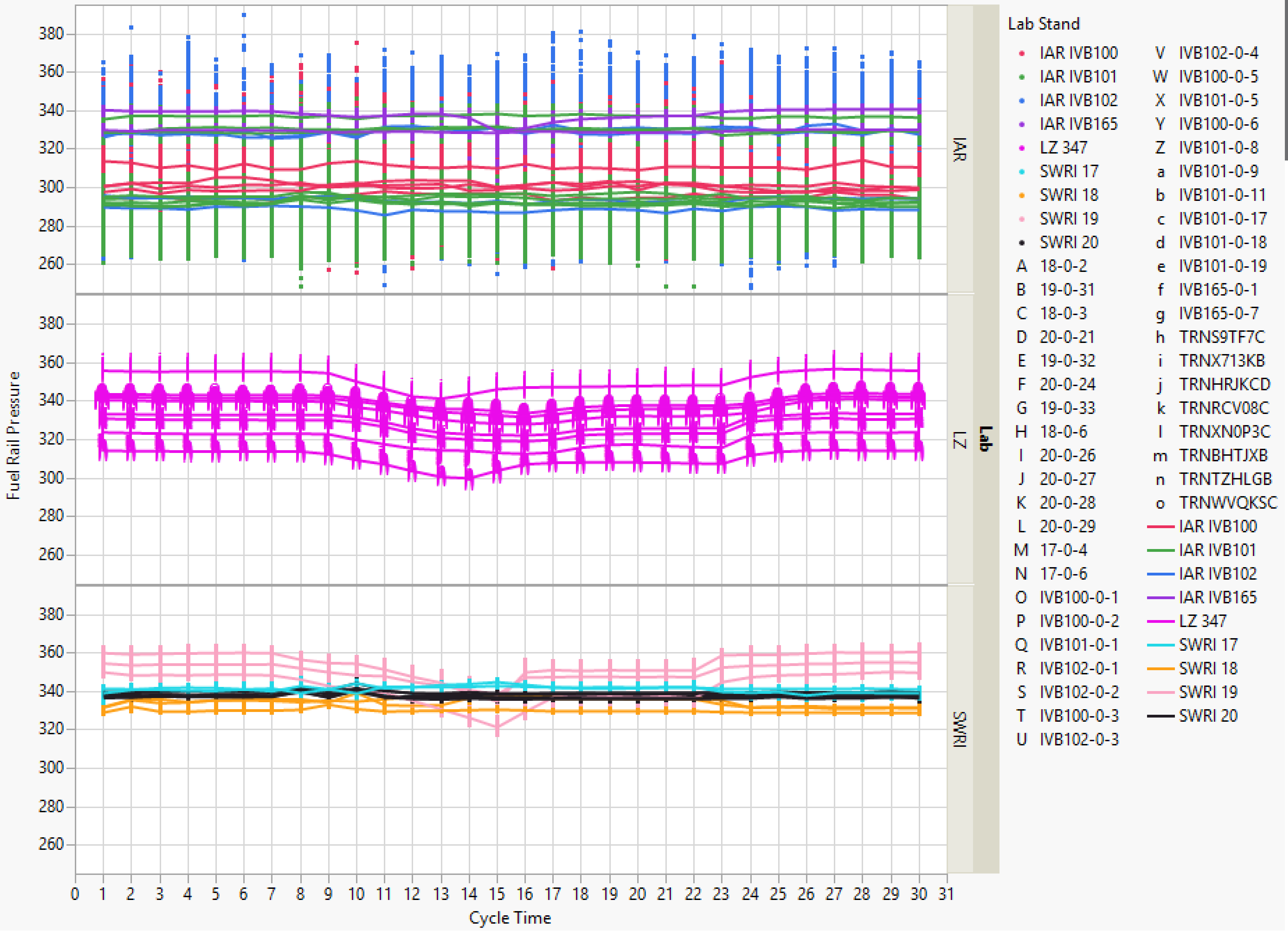
Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Exhaust Pressure
124
119
114
109
104
99
4
10
16
22
28
Cycle Time


Exhaust Pressure
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

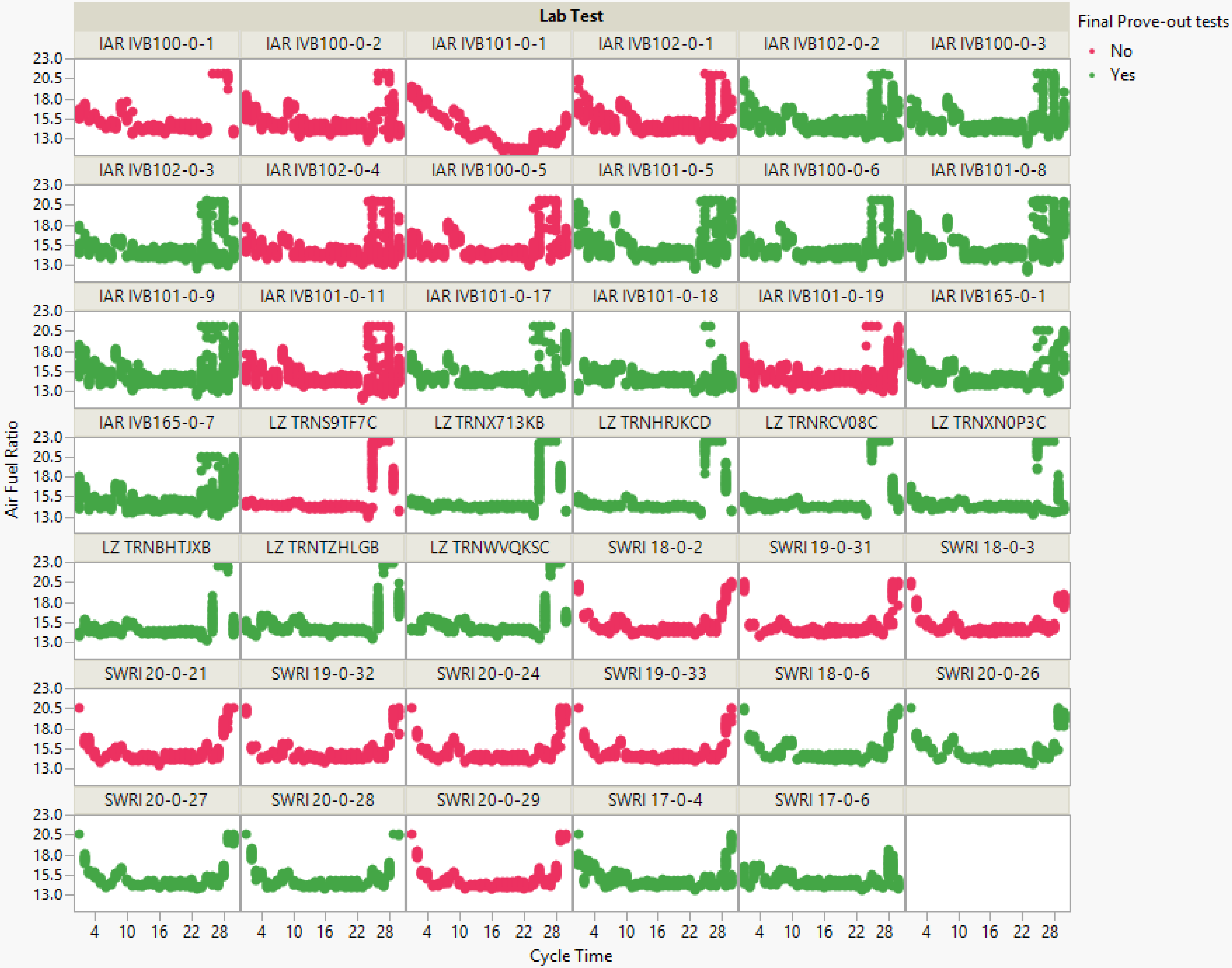

Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Coolant Inlet Pressure
84
76
68
60
4 10 16 22 28
Cycle Time


Coolant Inlet Pressure
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

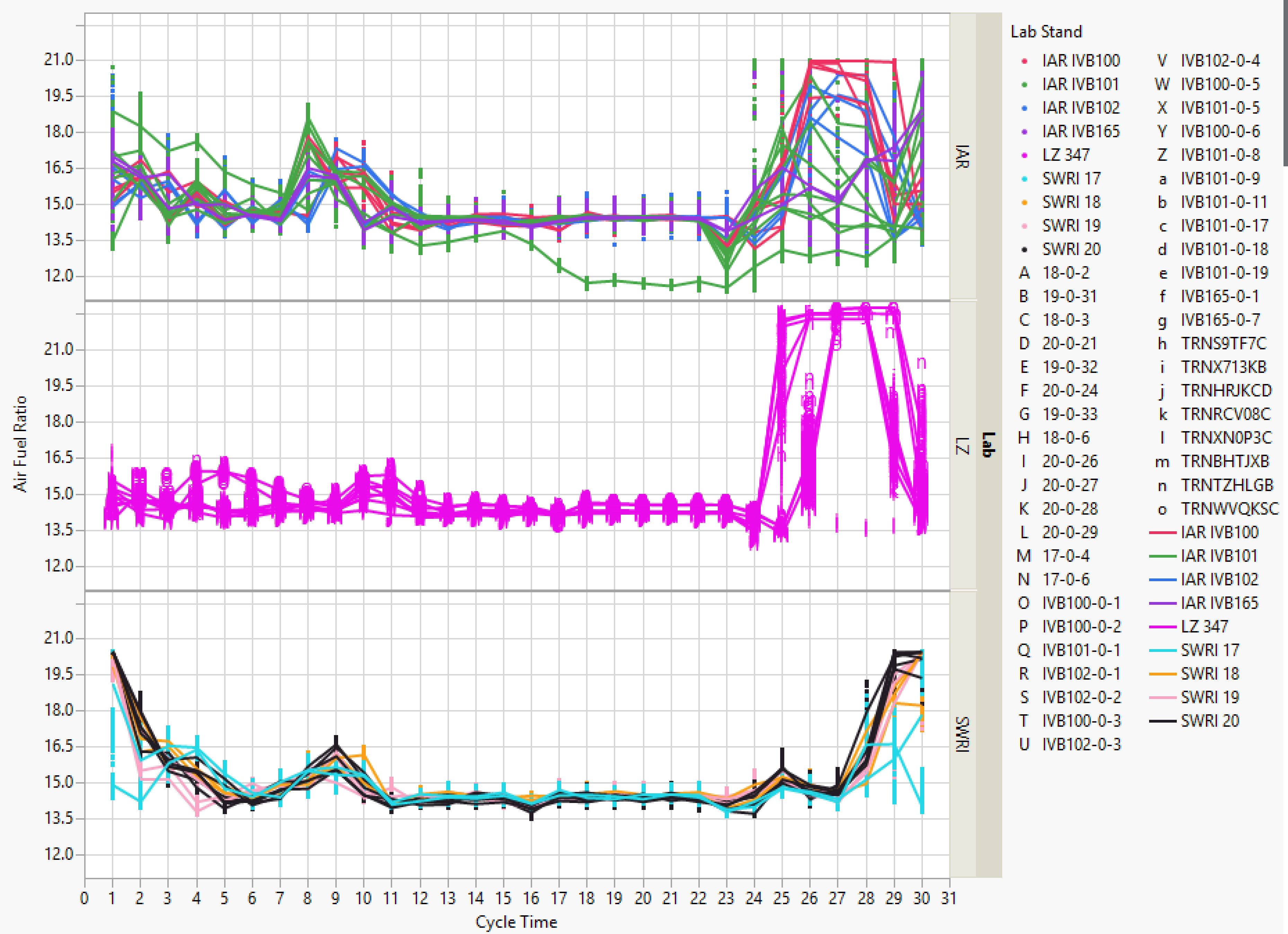
Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Fuel Rail Pressure
390
360
330
300
270
4
10
16
22
28
Cycle Time


Fuel Rail Pressure
380
360
340
320
300
280
260
IAR
LZ
SWRI
Lab
Cycle Time
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

Operational Data Plots
Uncontrolled Parameters

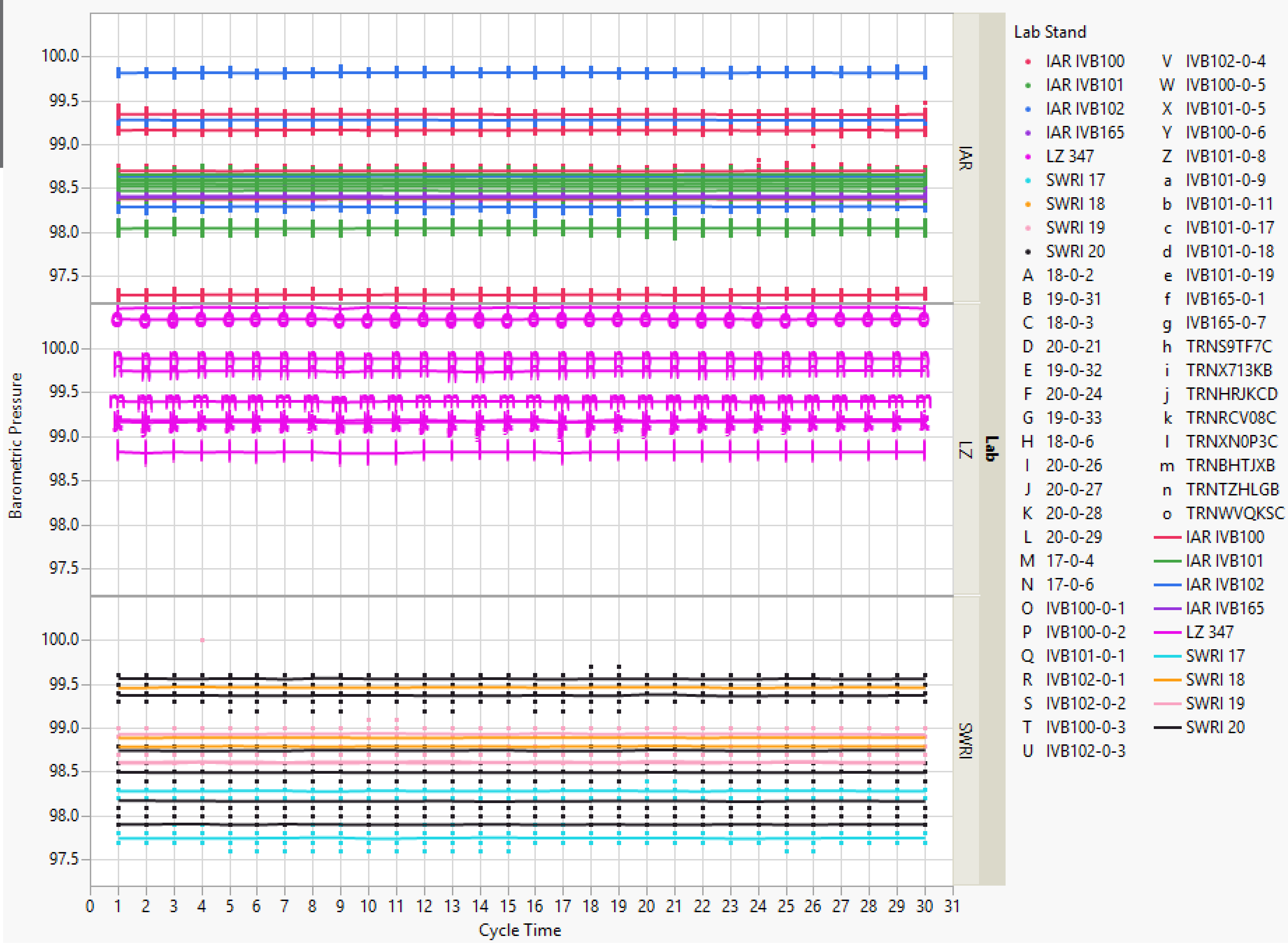


Lab Test
Final Prove-out tests
No
Yes
Air Fuel Ratio
Cycle Time
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
23.0
20.5
18.0
15.5
13.0
4
10
16
22
28

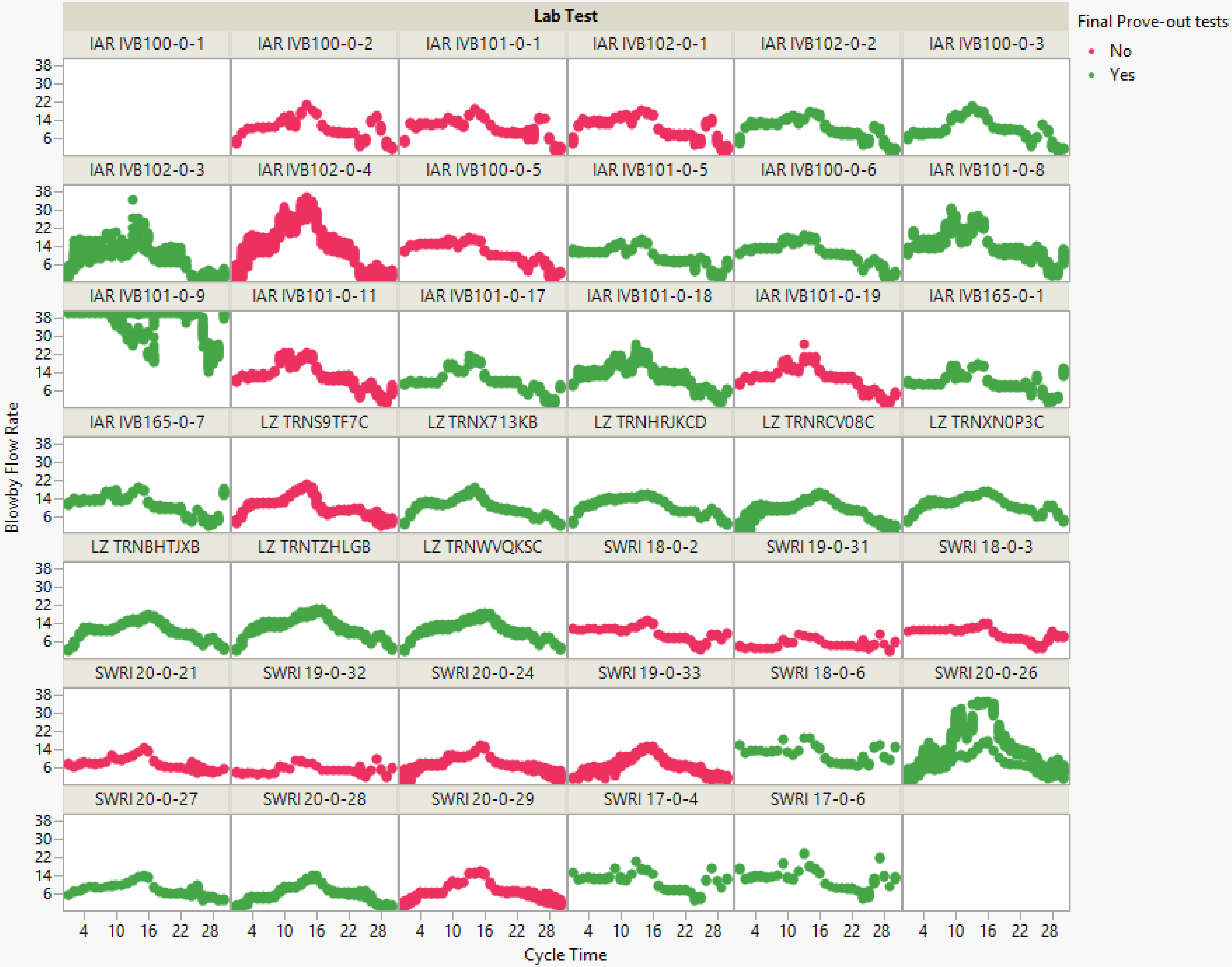


Air Fuel Ratio
21.0
19.5
18.0
16.5
15.0
13.5
12.0
IAR
LZ
SWRI
Lab
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Cycle Time
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

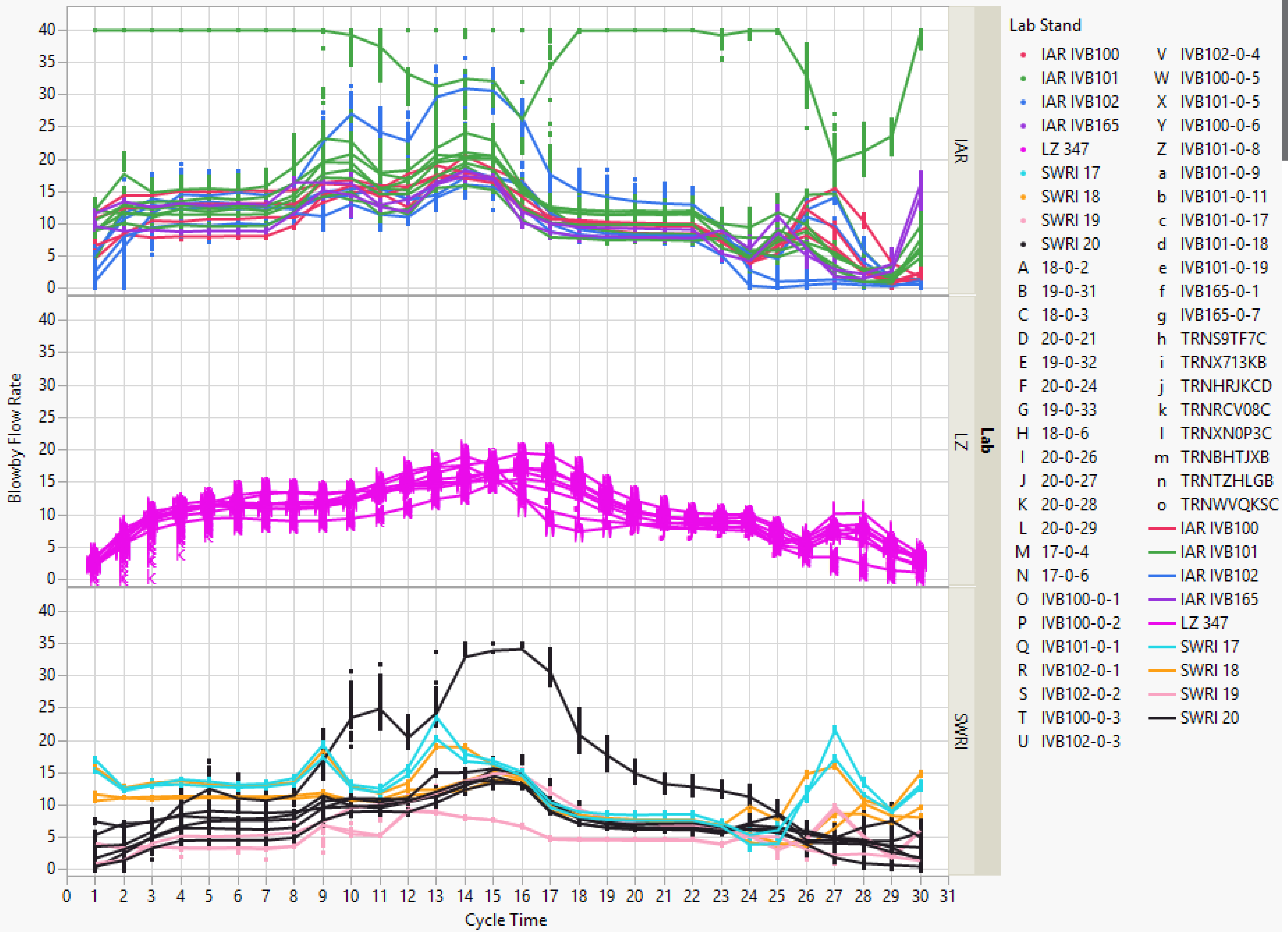

Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Barometric Pressure
100.2
99.4
98.6
97.8
Cycle Time
4
10
16
22
28



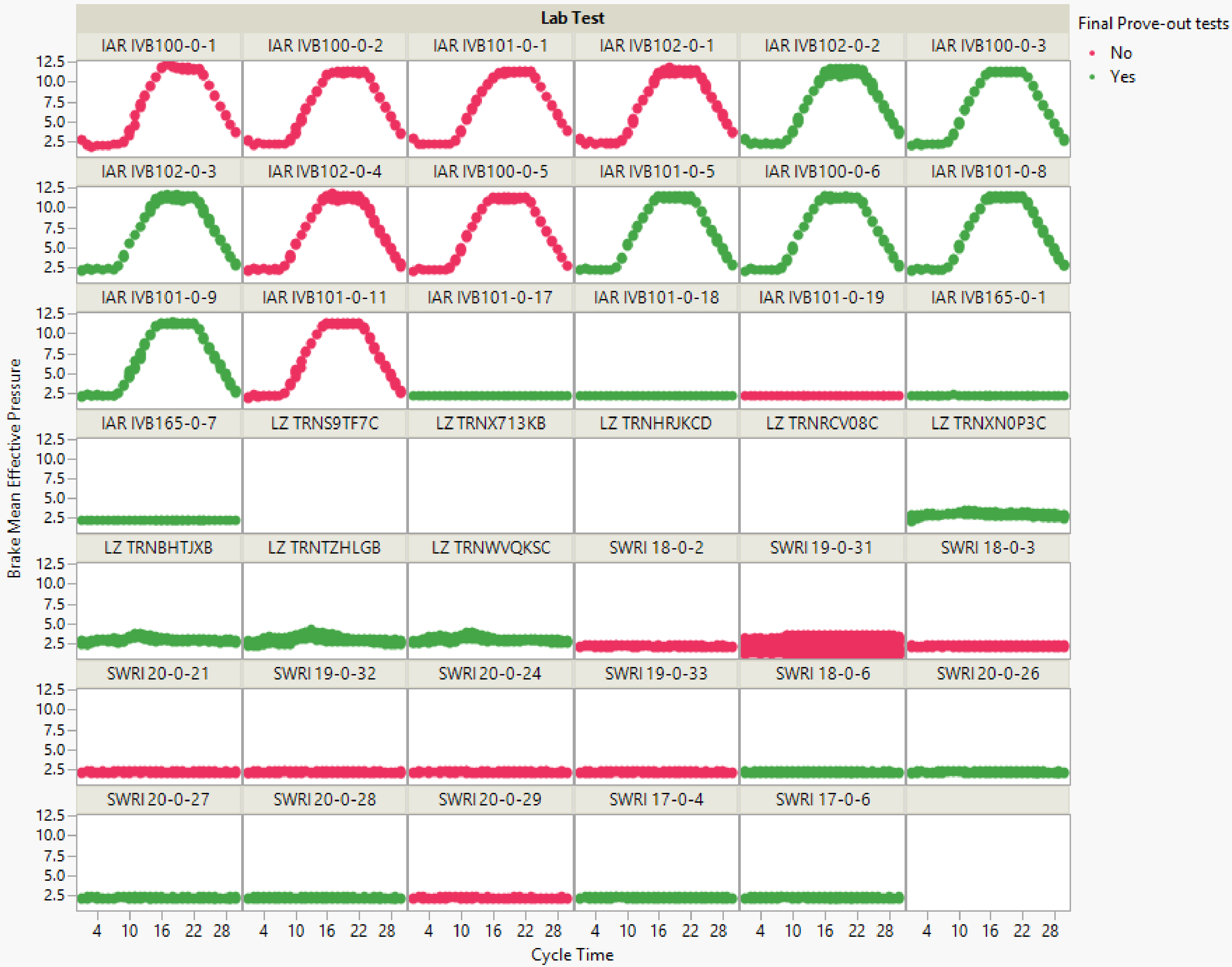
Barometric Pressure
100.0
99.5
99.0
98.5
98.0
97.5
IAR
LZ
SWRI
Lab
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Cycle Time
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20



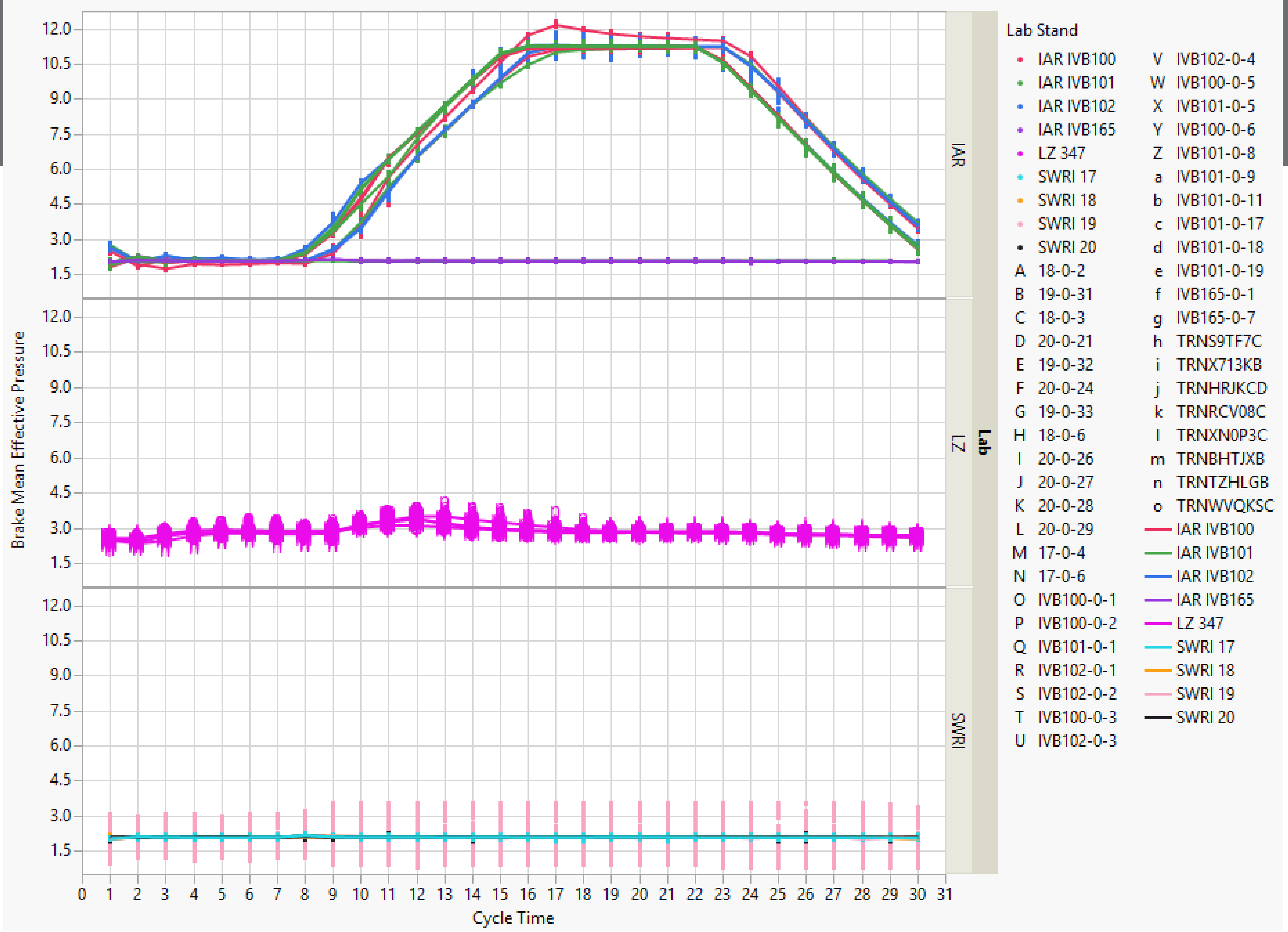
Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Blowby Flow Rate
38
30
22
14
6
4
10
16
22
28
Cycle Time

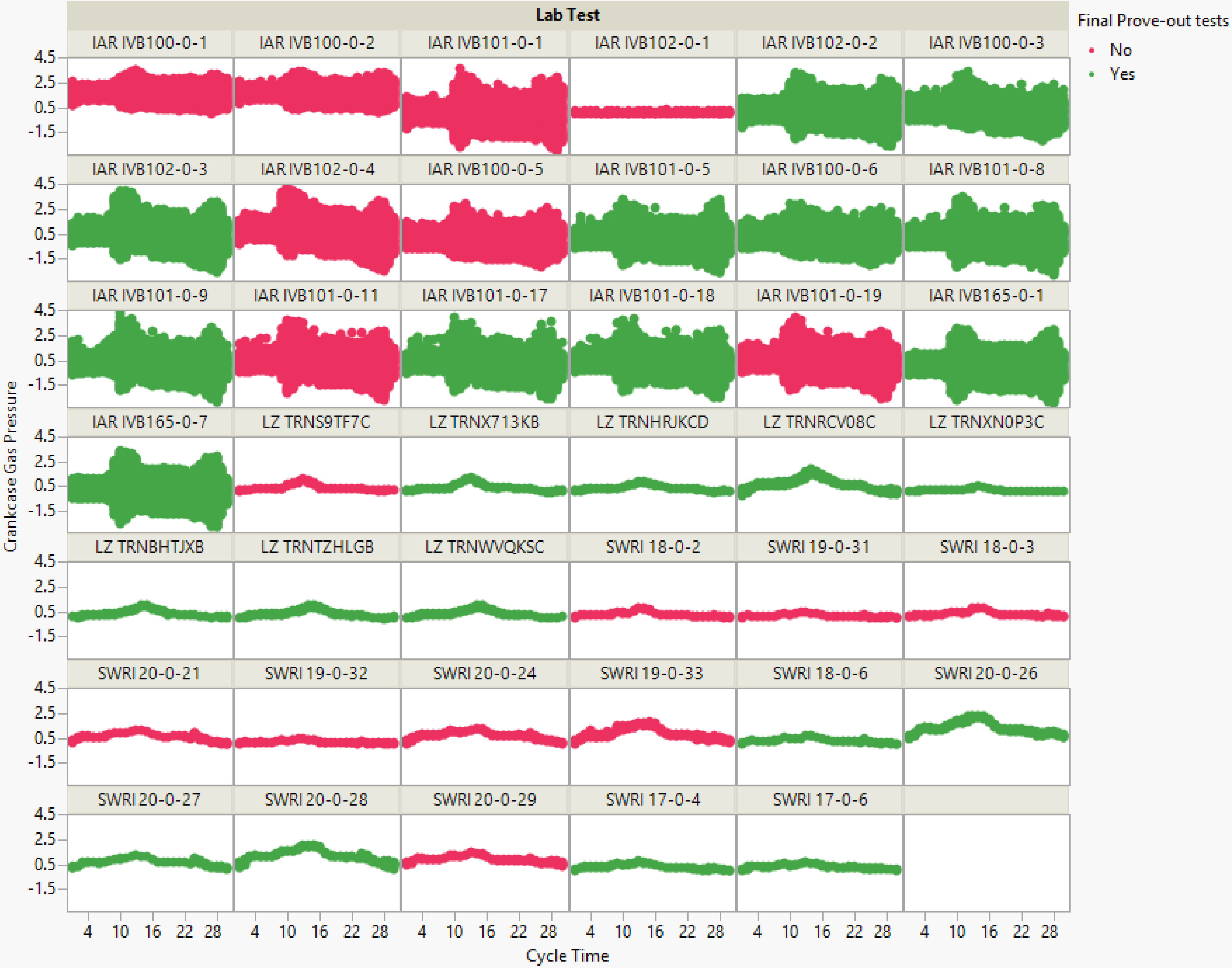

Blowby Flow Rate
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC

Lubrizol

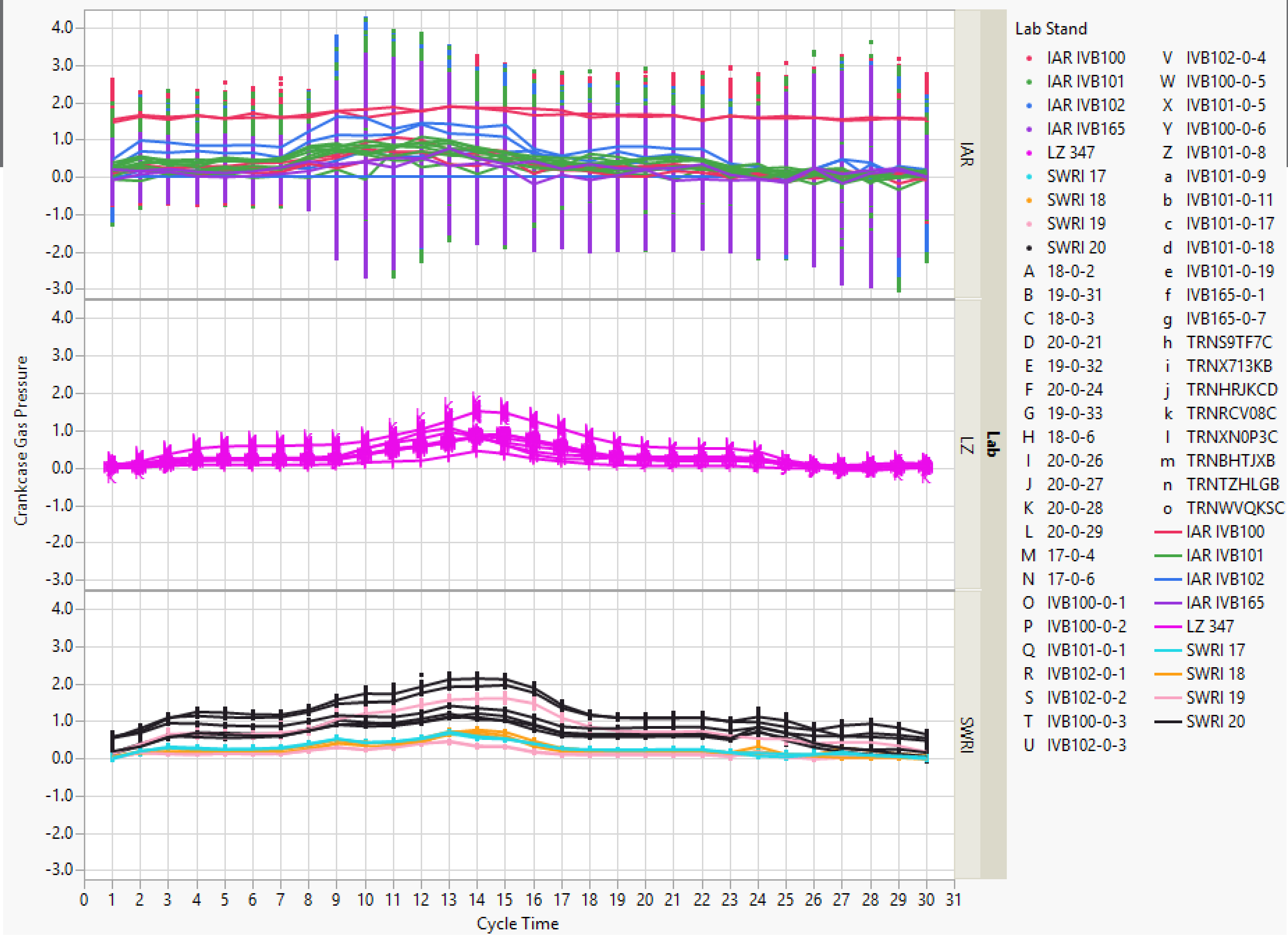


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Brake Mean Effective Pressure
12.5
10.0
7.5
5.0
2.5
Cycle Time
4
10
16
22
28


Brake Mean Effective Pressure
Cycle Time
IAR
LZ
SWRI
Lab
12.0
10.5
9.0
7.5
6.0
4.5
3.0
1.5
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

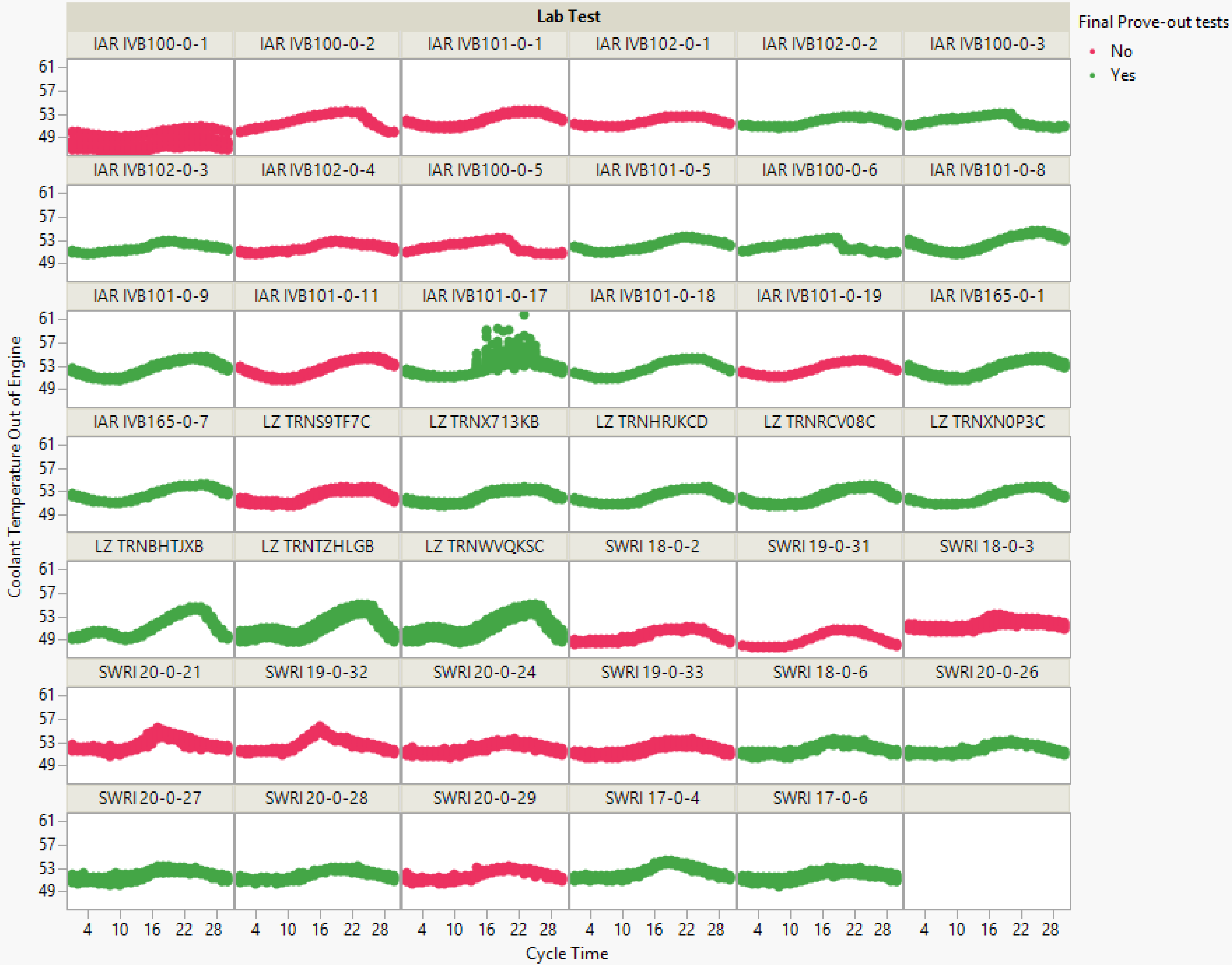


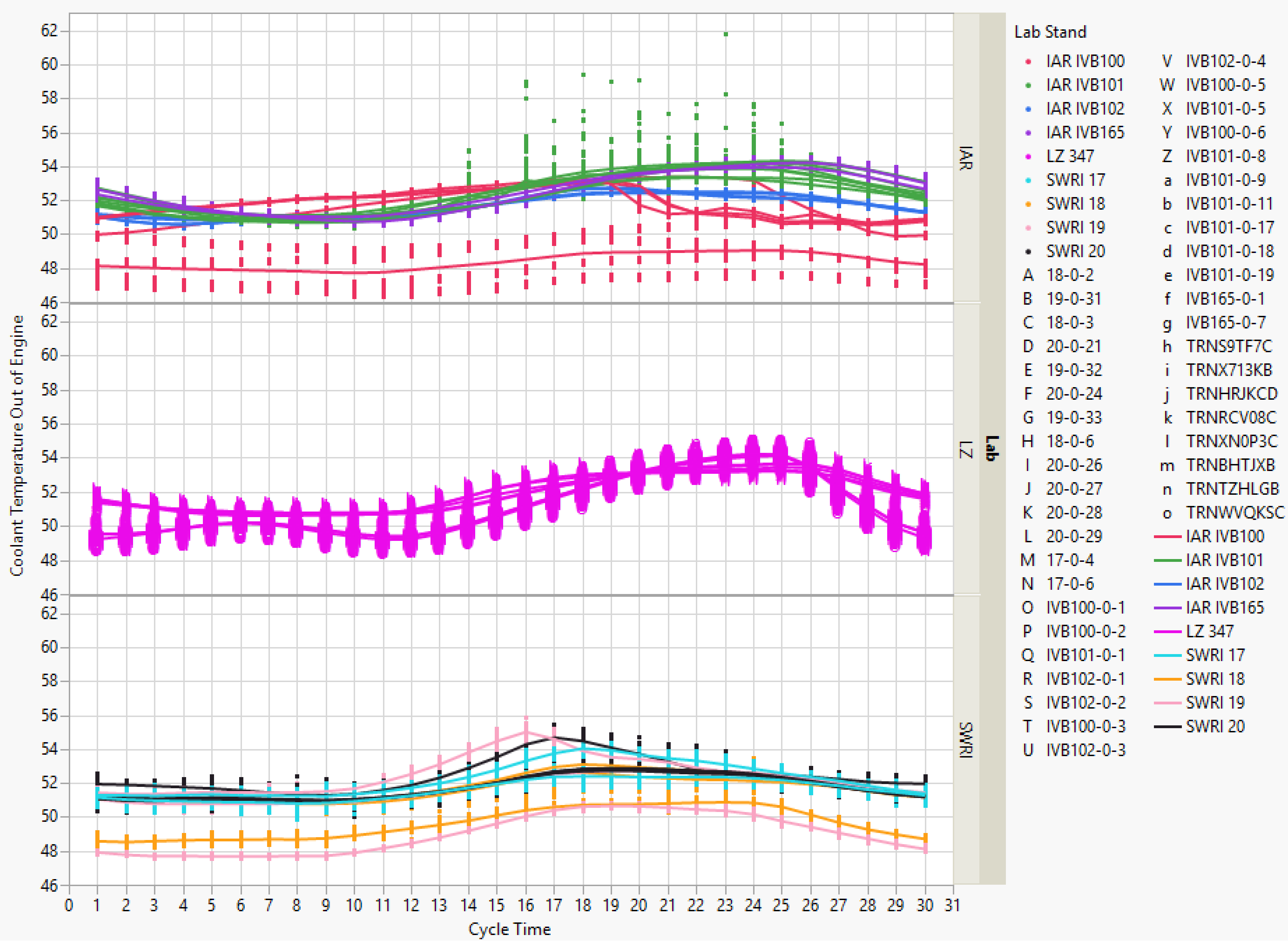
Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Crankcase Gas Pressure
4.5
2.5
0.5
-1.5
Cycle Time
4
10
16
22
28



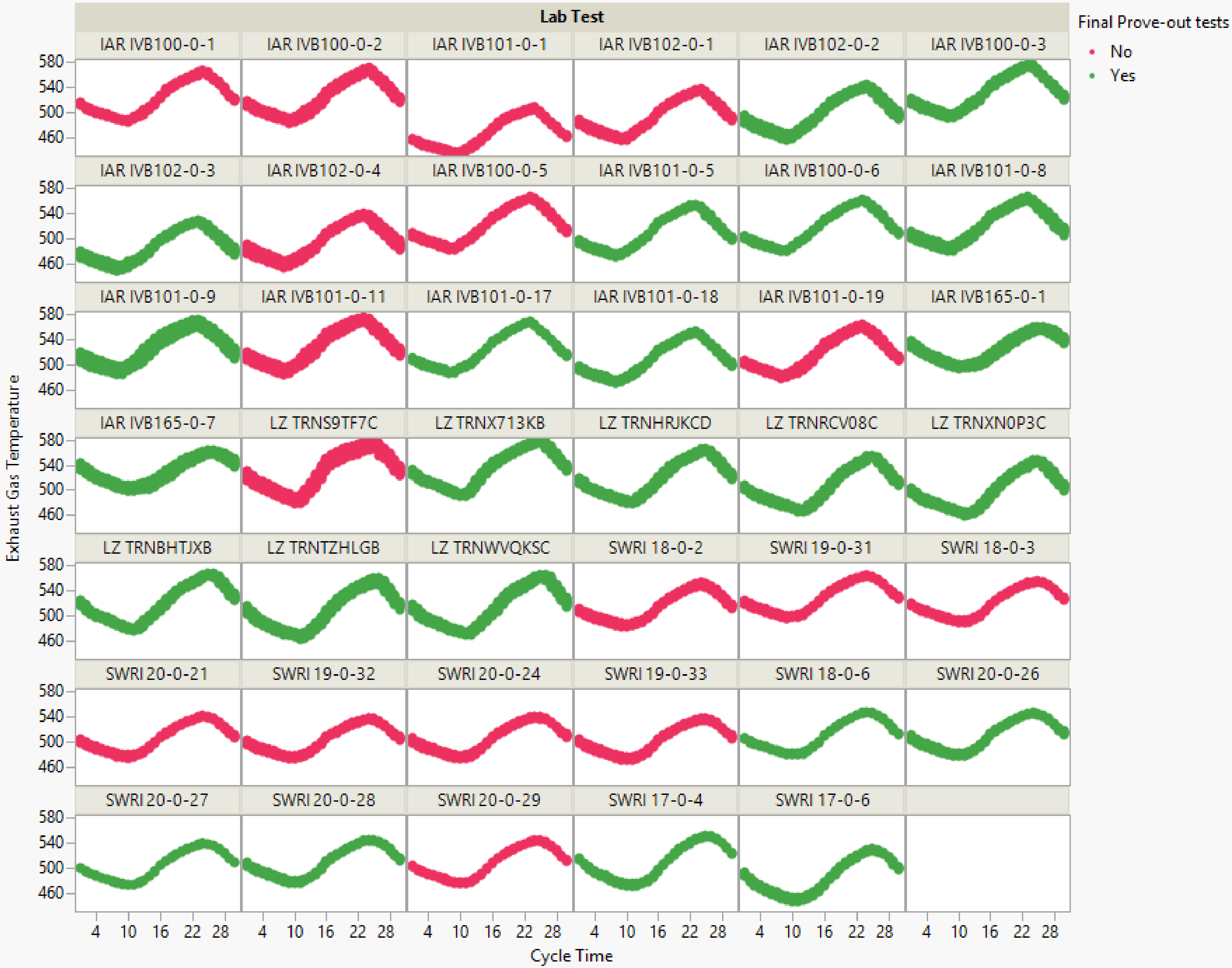
Crankcase Gas Pressure
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC

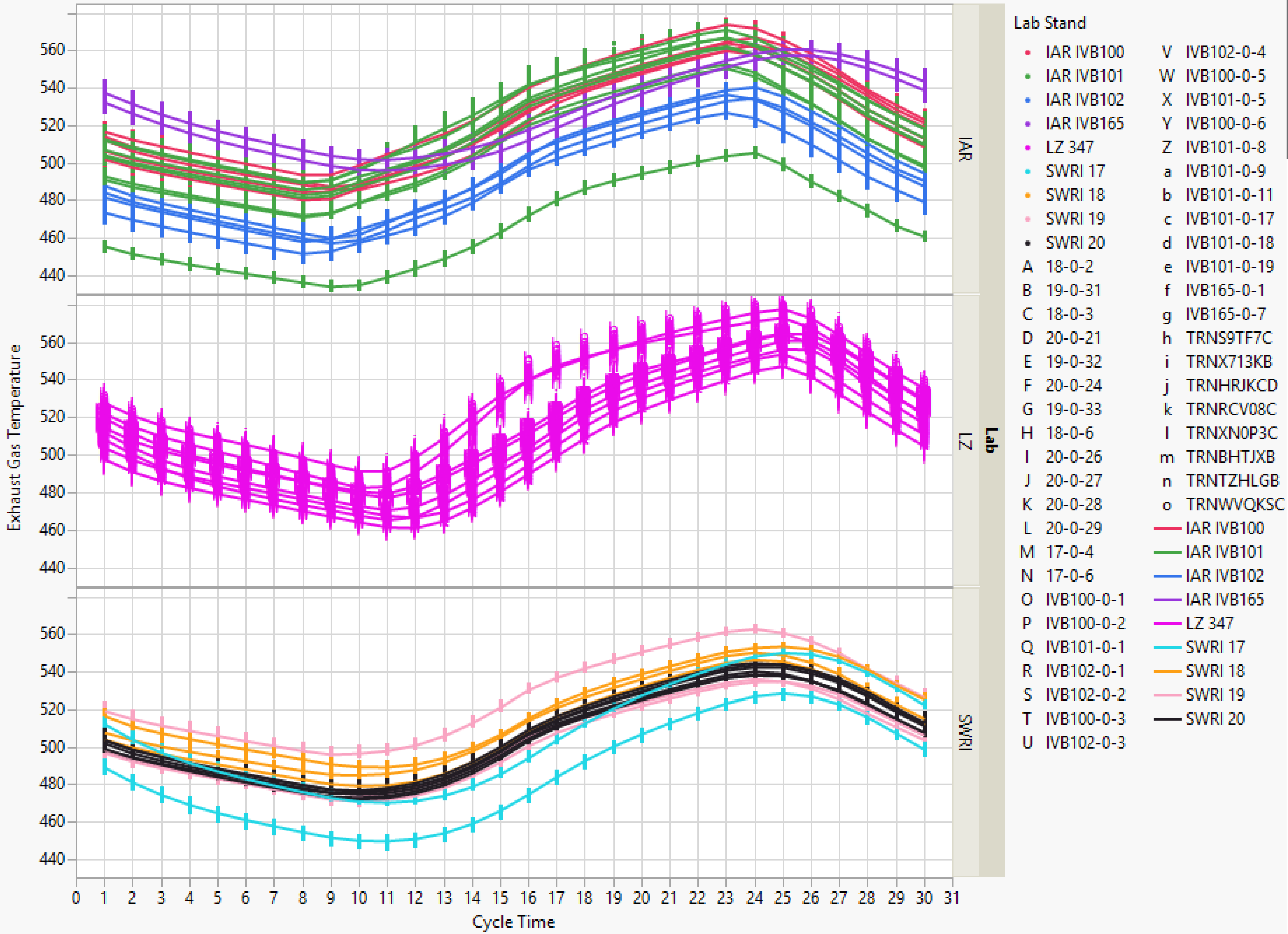
Lubrizol

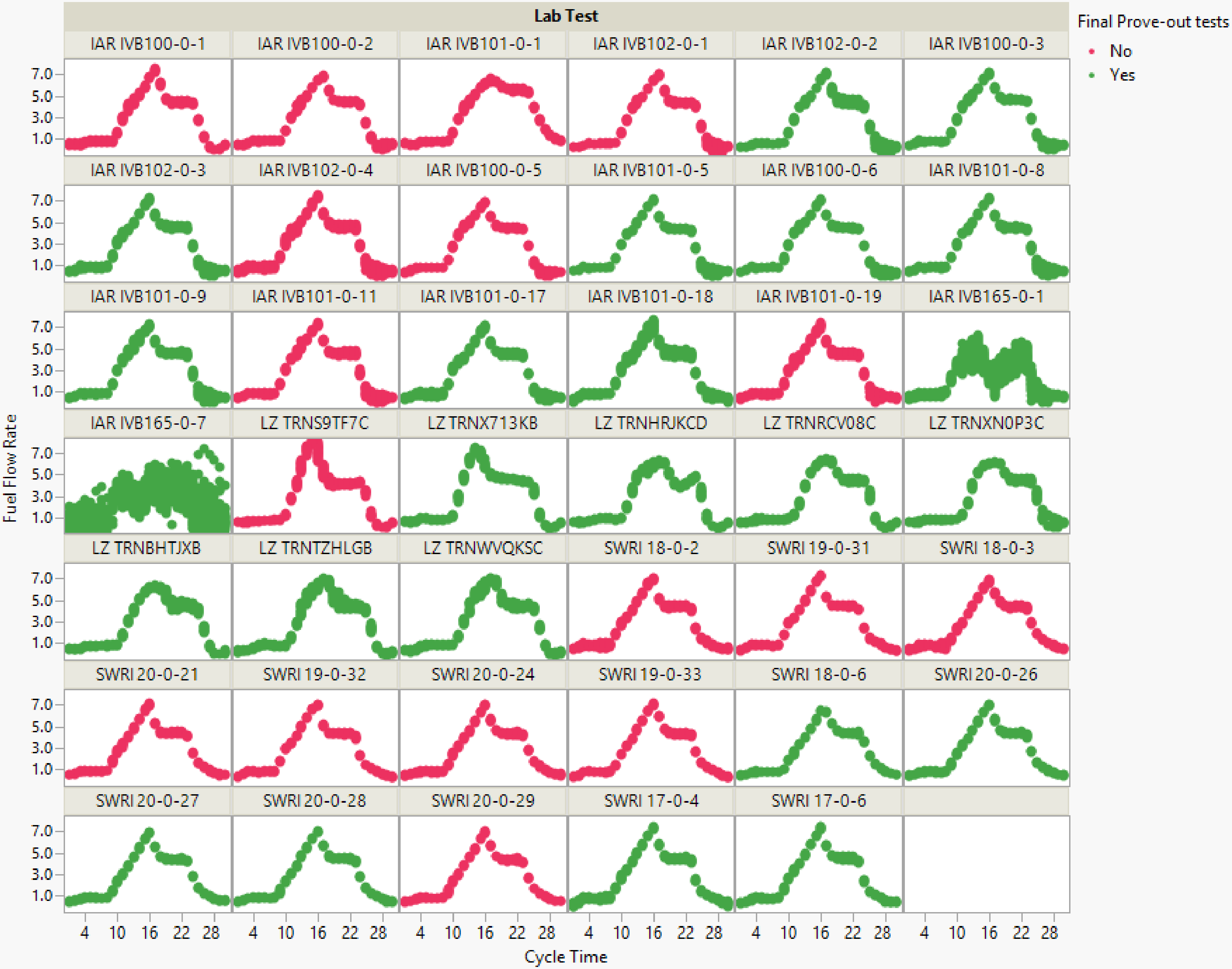

Lab Test
Final Prove-out tests
No
Yes
Coolant Temperature Out of Engine
Cycle Time
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6

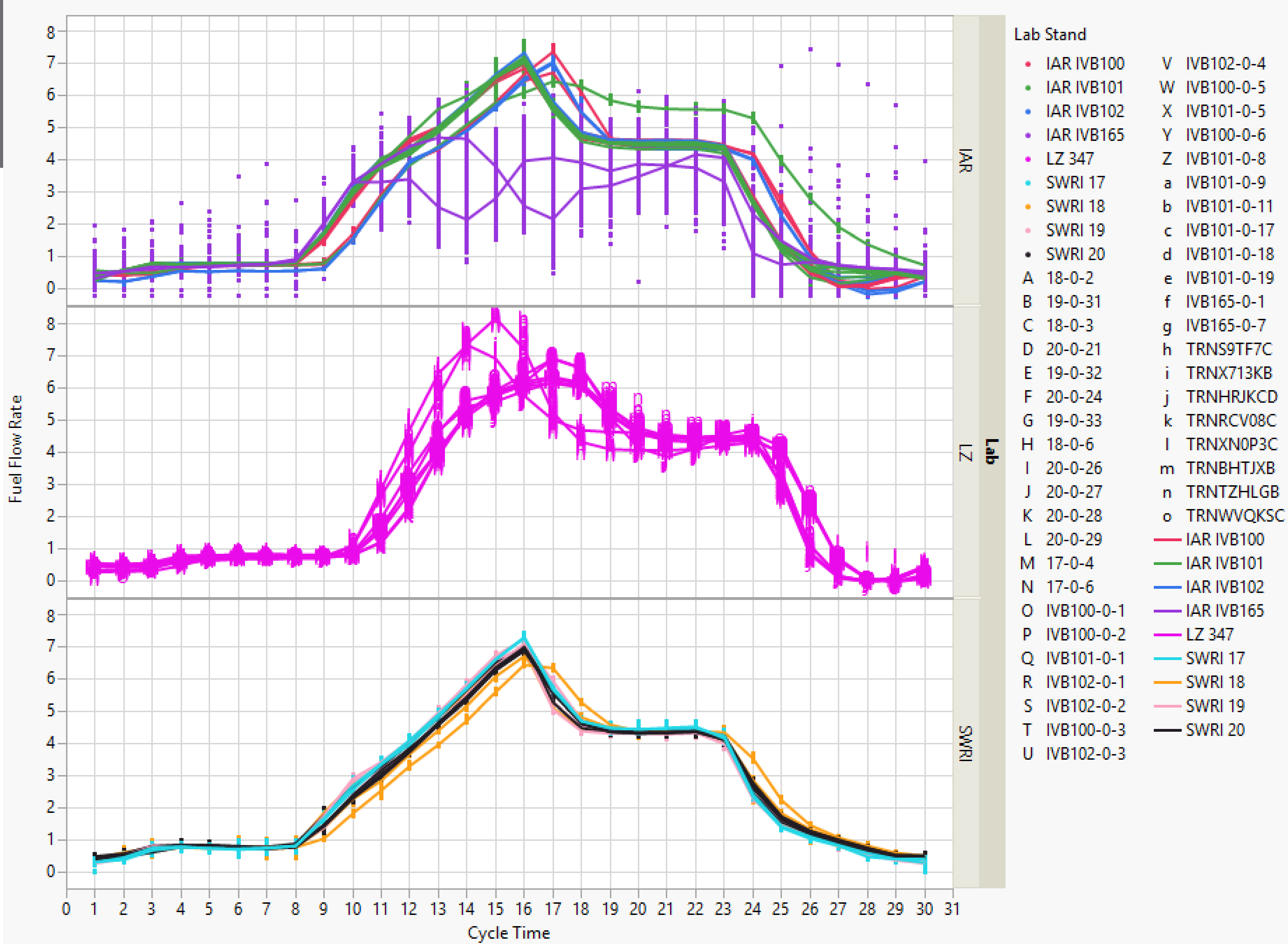


Coolant Temperature Out of Engine
Cycle Time
Lab
IAR
LZ
SWRI
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Exhaust Gas Temperature
580
540
500
460
Cycle Time
4
10
16
22
28

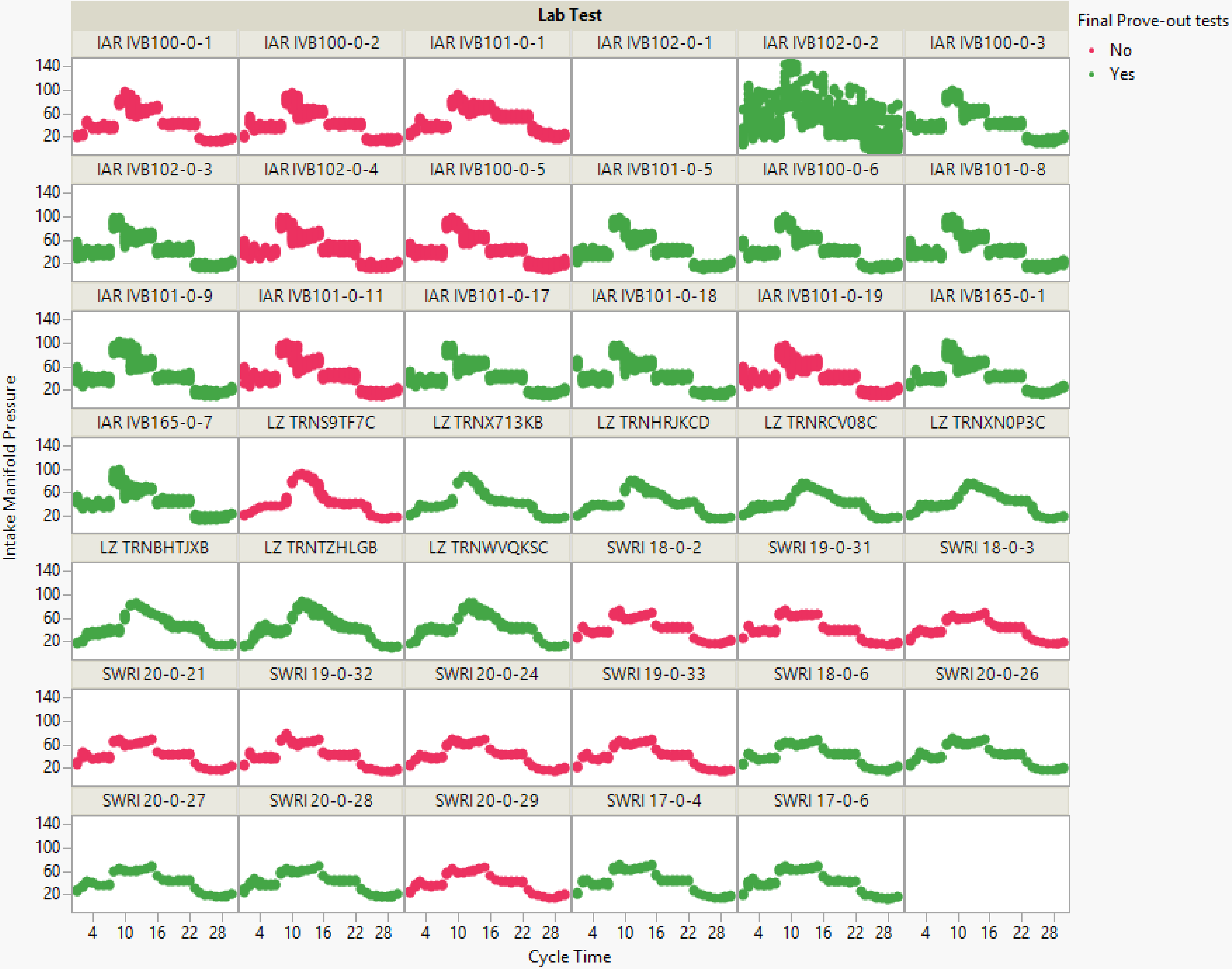

Exhaust Gas Temperature
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Fuel Flow Rate
7.0
5.0
3.0
1.0
4
10
16
22
28
Cycle Time

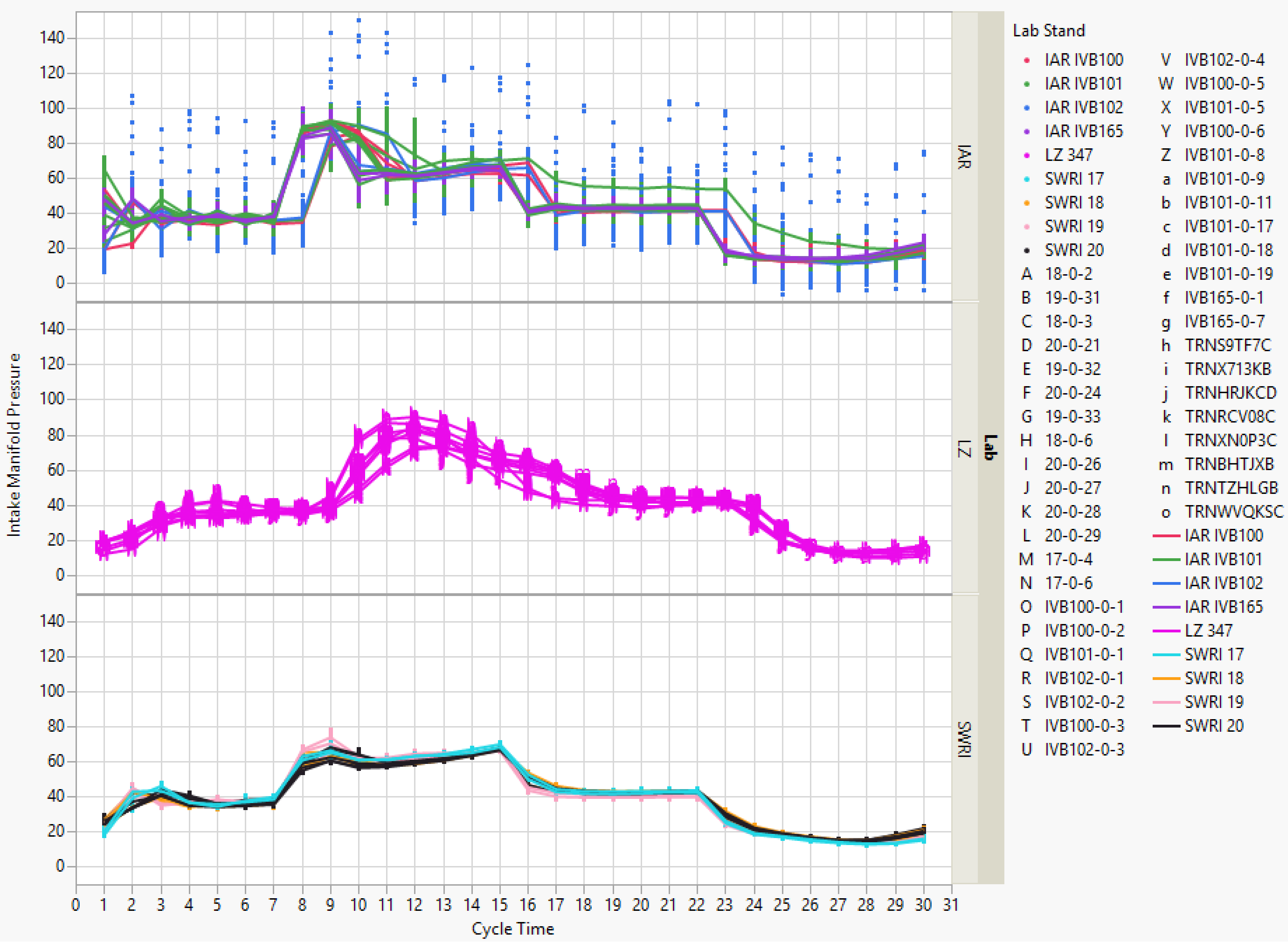


Fuel Flow Rate
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

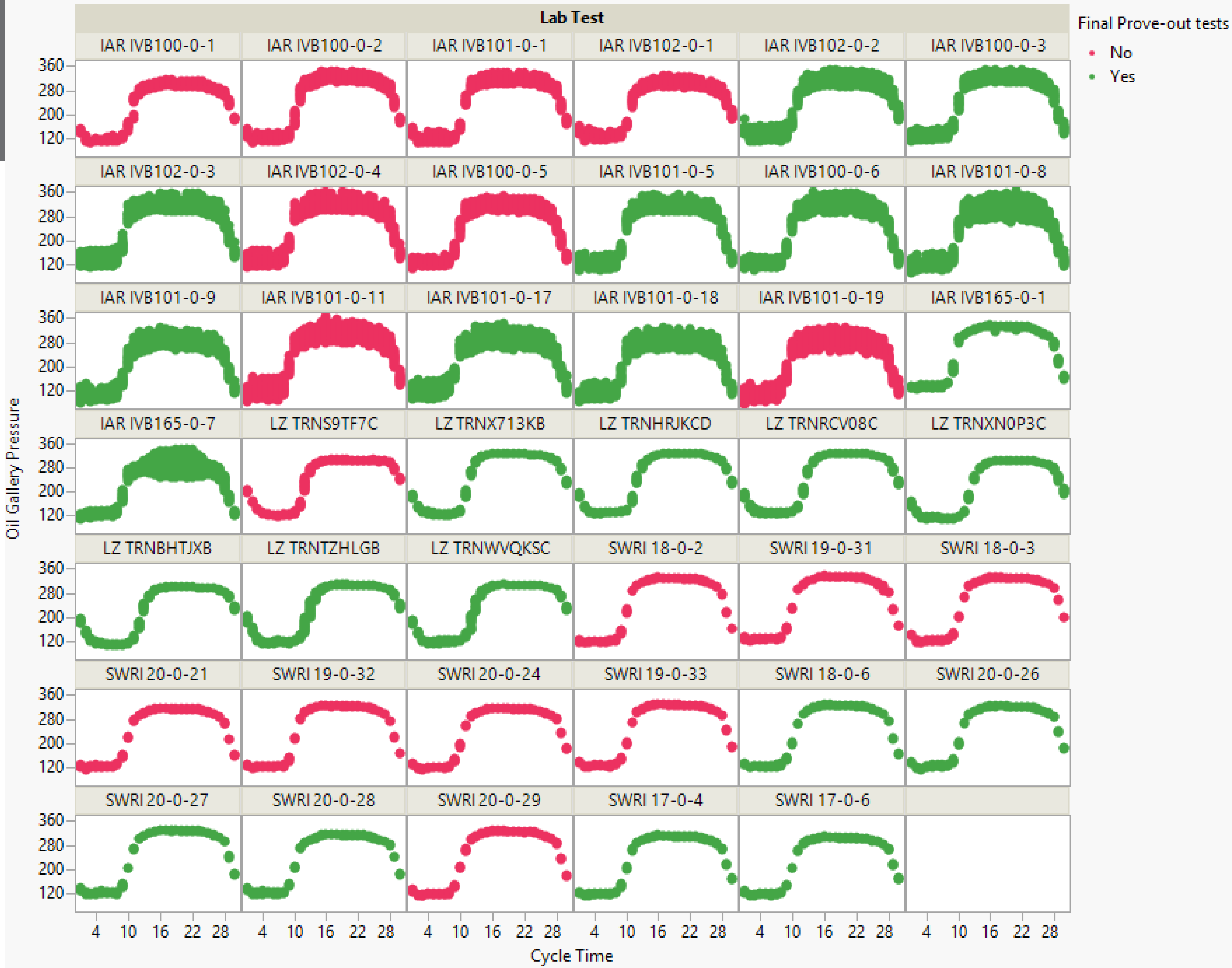
Lubrizol

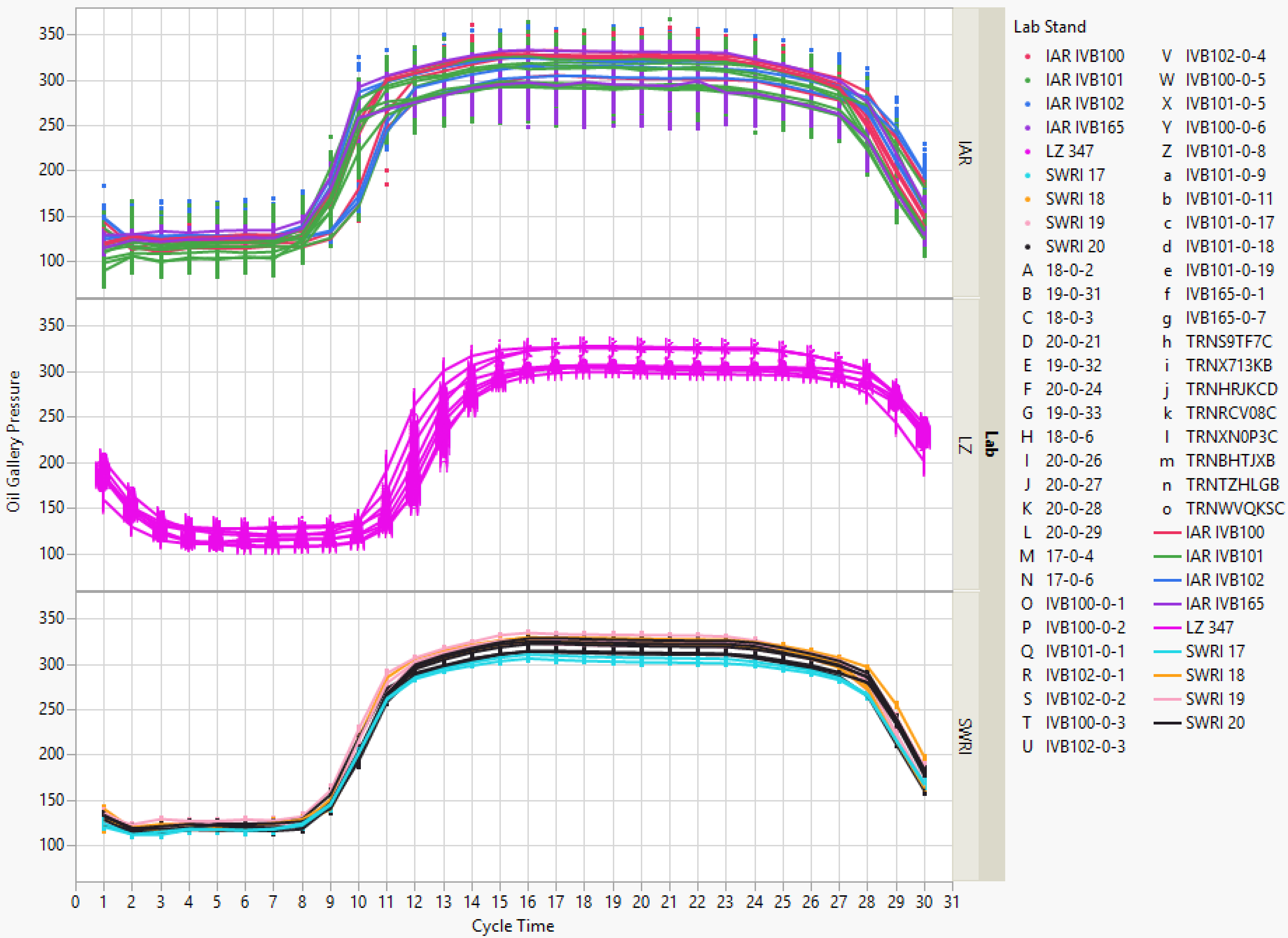


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Intake Manifold Pressure
140
100
60
20
4
10
16
22
28
Cycle Time

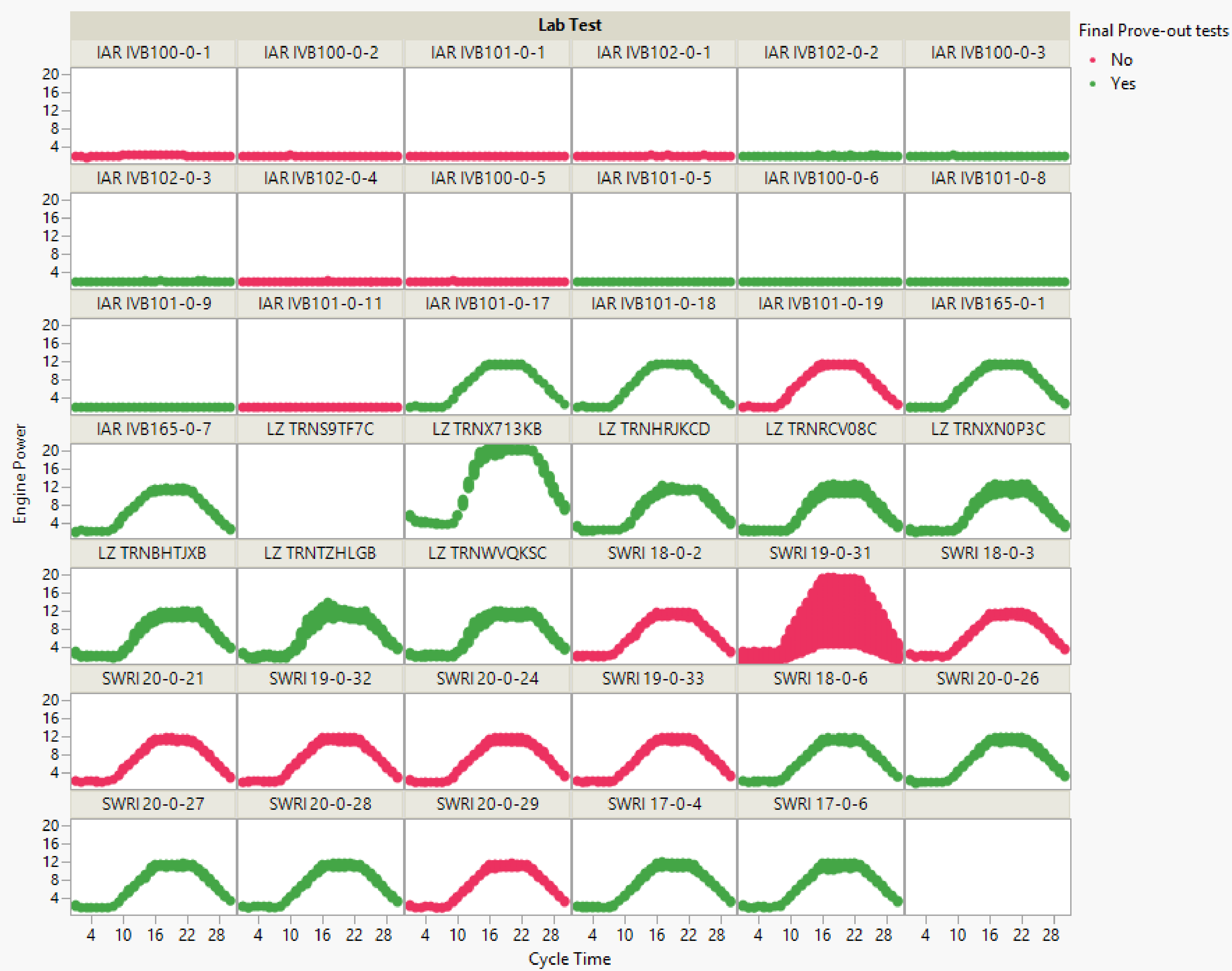


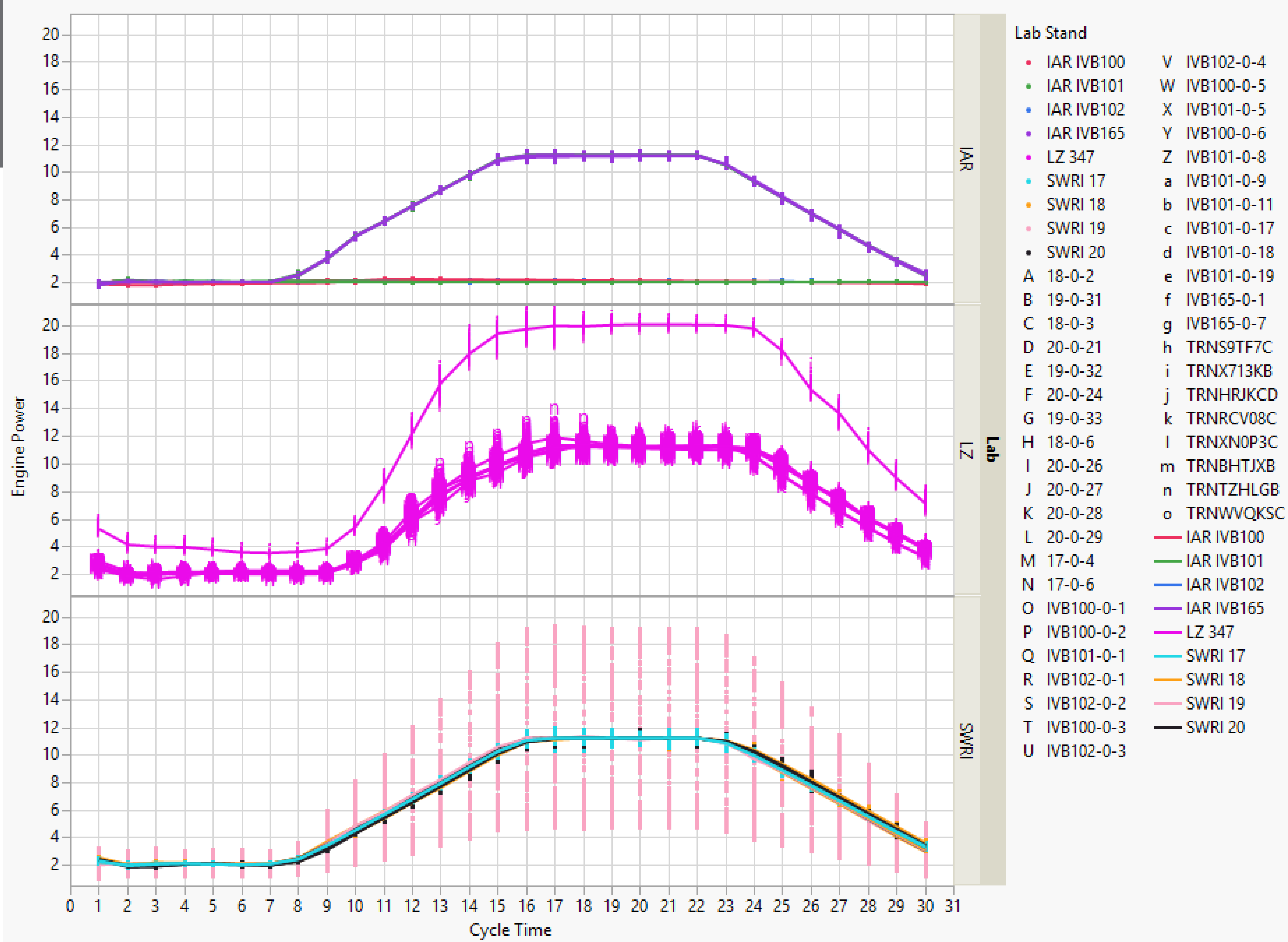
Intake Manifold Pressure
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20


Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Oil Gallery Pressure
360
280
200
120
Cycle Time
4
10
16
22
28

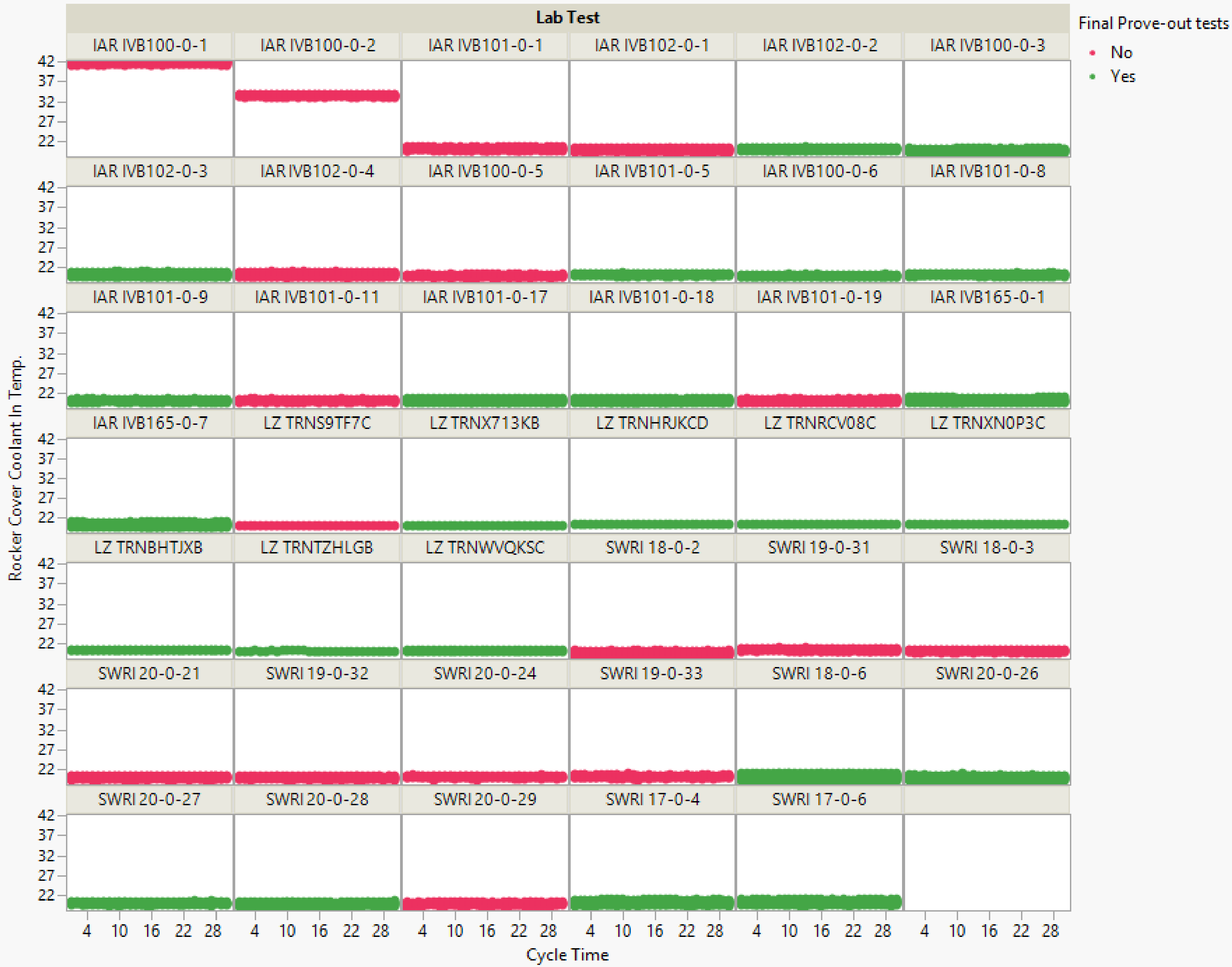


Oil Gallery Pressure
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC

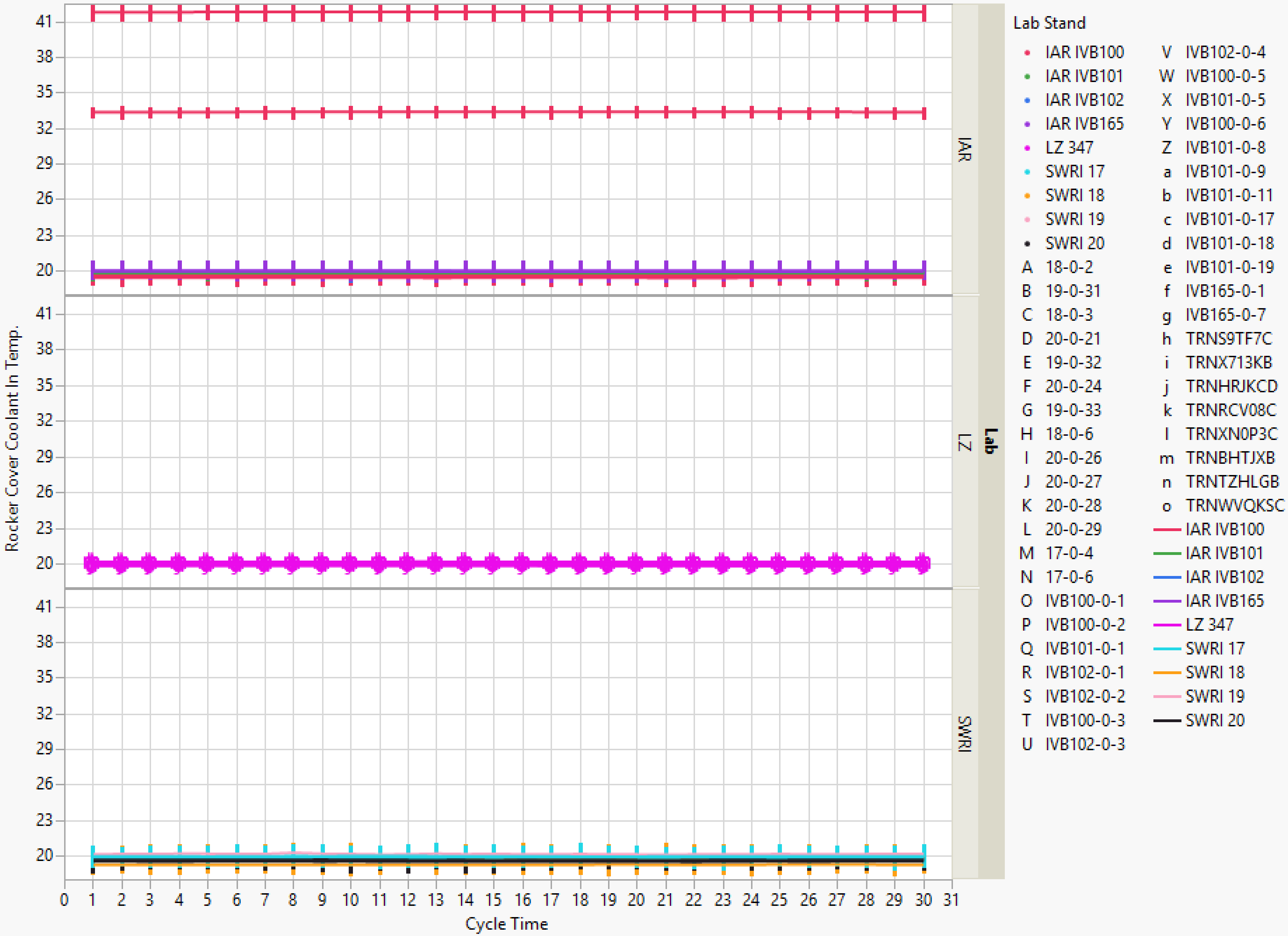

Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Engine Power
20
16
12
8
4
4 10 16 22 28
Cycle Time



Engine Power
Cycle Time
Lab
IAR
LZ
SWRI
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC

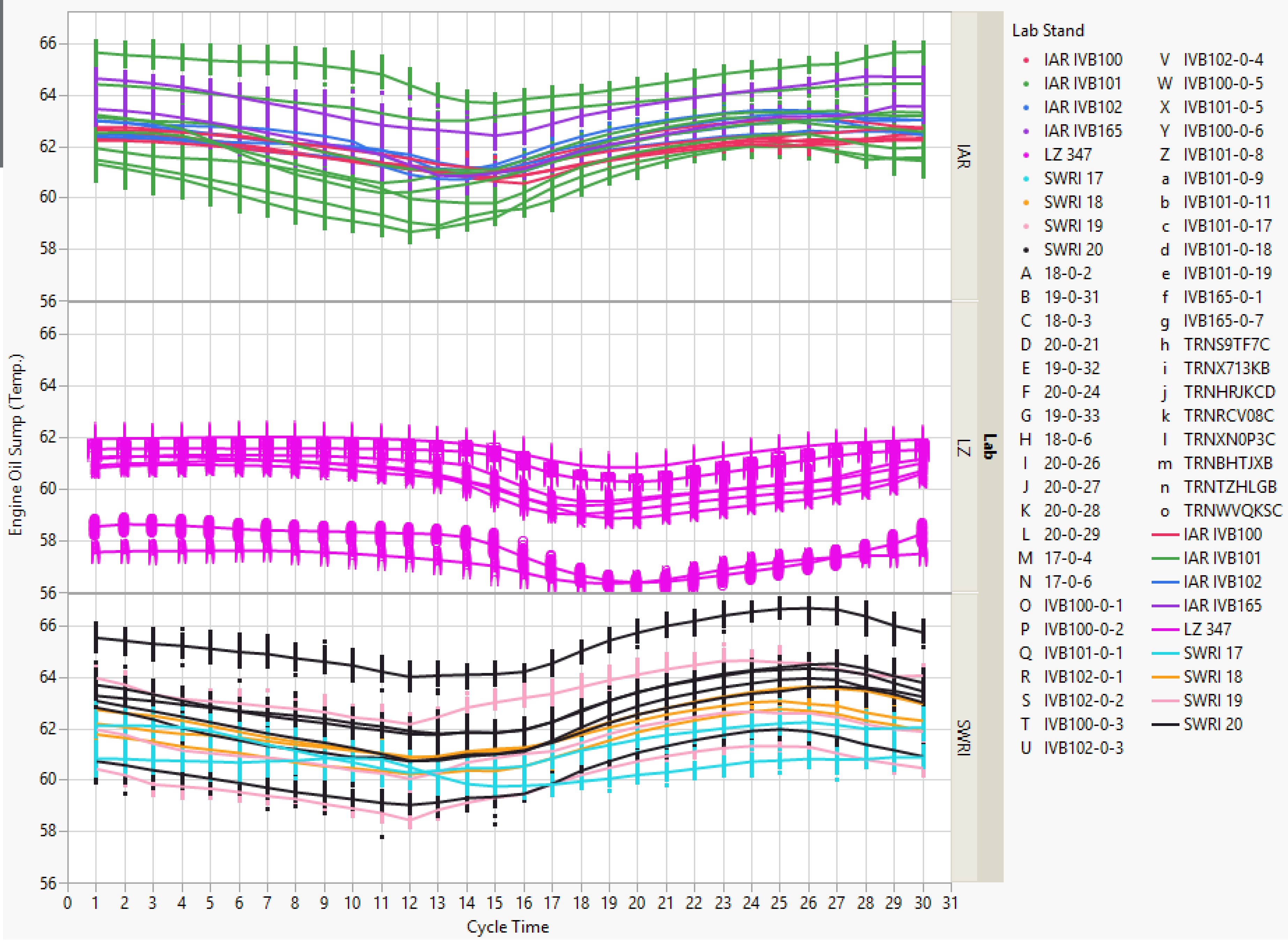


Lab Test
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Rocker Cover Coolant In Temp.
42
37
32
27
22
4
10
16
22
28
Cycle Time
Final Prove-out tests
No
Yes

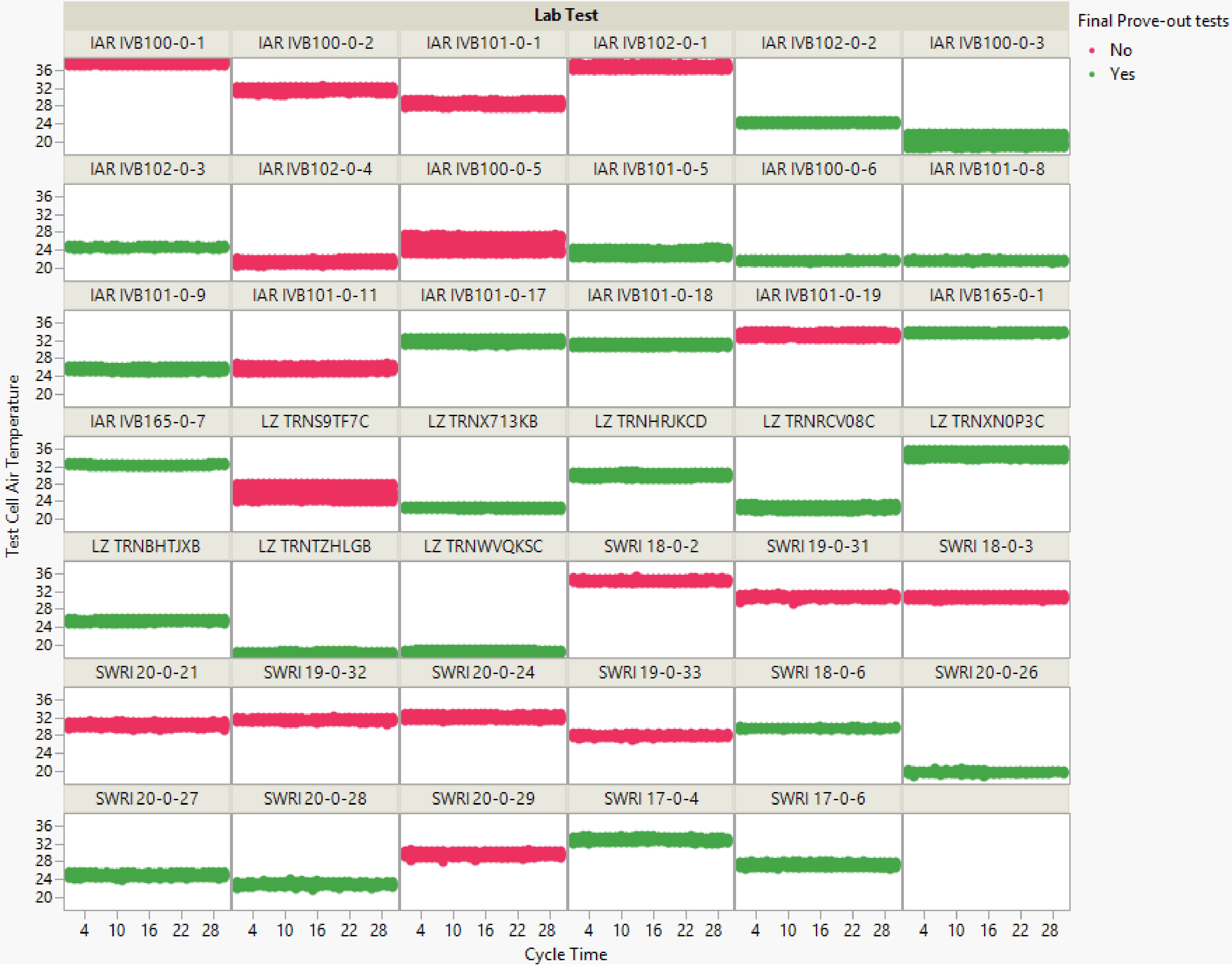


Rocker Cover Coolant In Temp.
41
38
35
32
29
26
23
20
IAR
LZ
SWRI
Lab
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Cycle Time
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

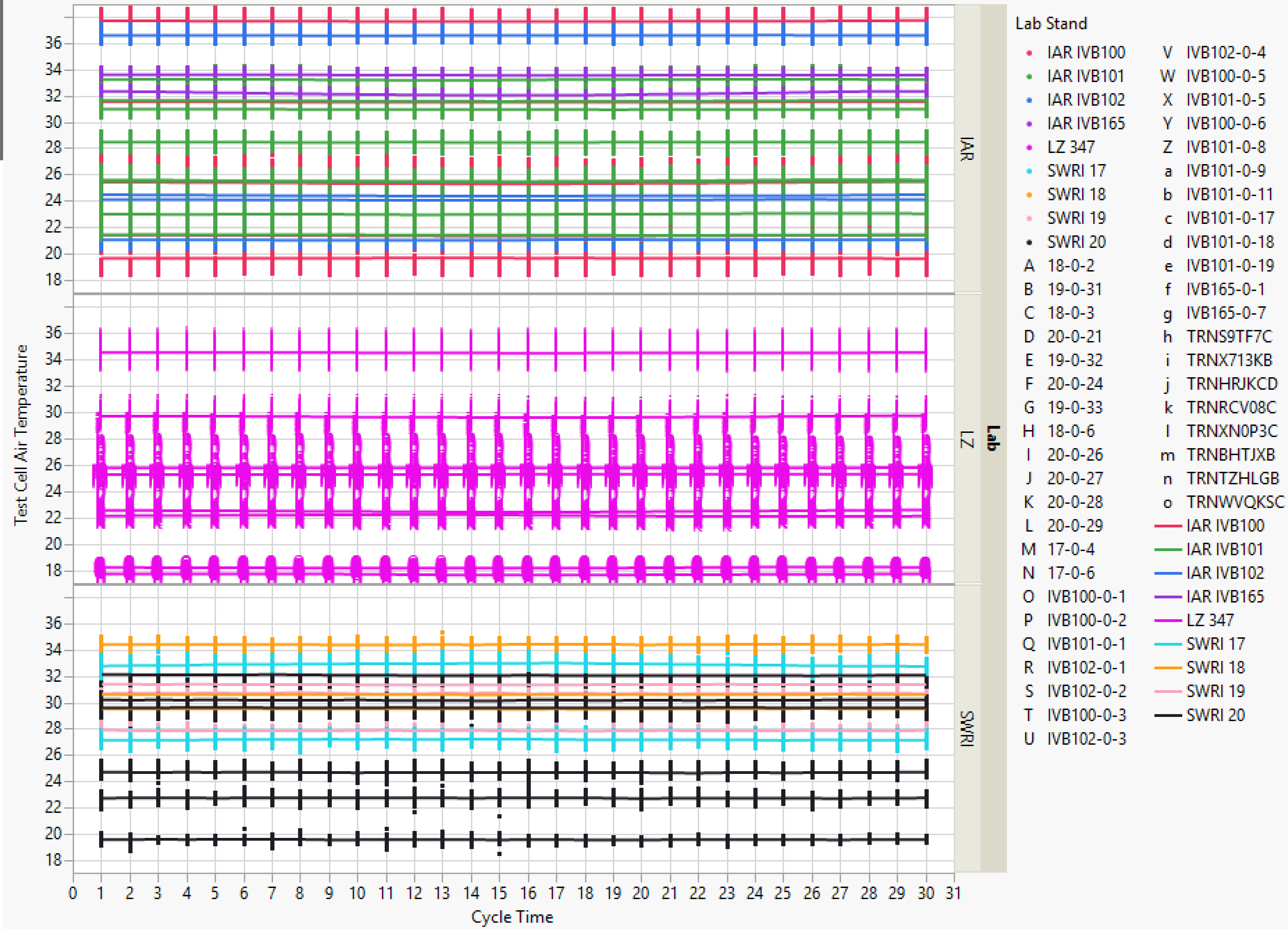

Lab Test
Final Prove-out tests
No
Yes
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
Engine Oil Sump (Temp.)
65.5
63.5
61.5
59.5
57.5
4
10
16
22
28
Cycle Time

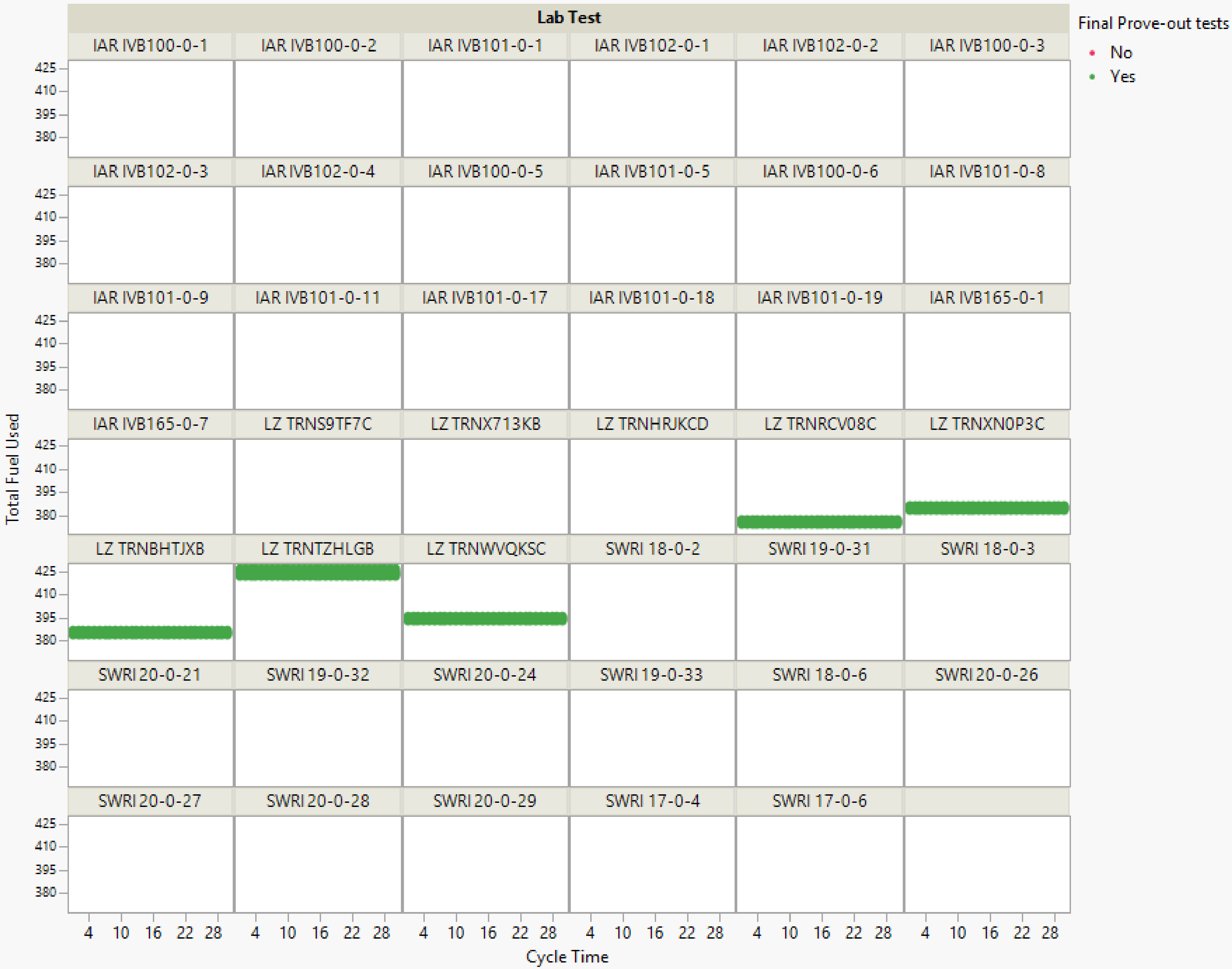


Engine Oil Sump (Temp.)
Cycle Time
Lab
IAR
LZ
SWRI
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

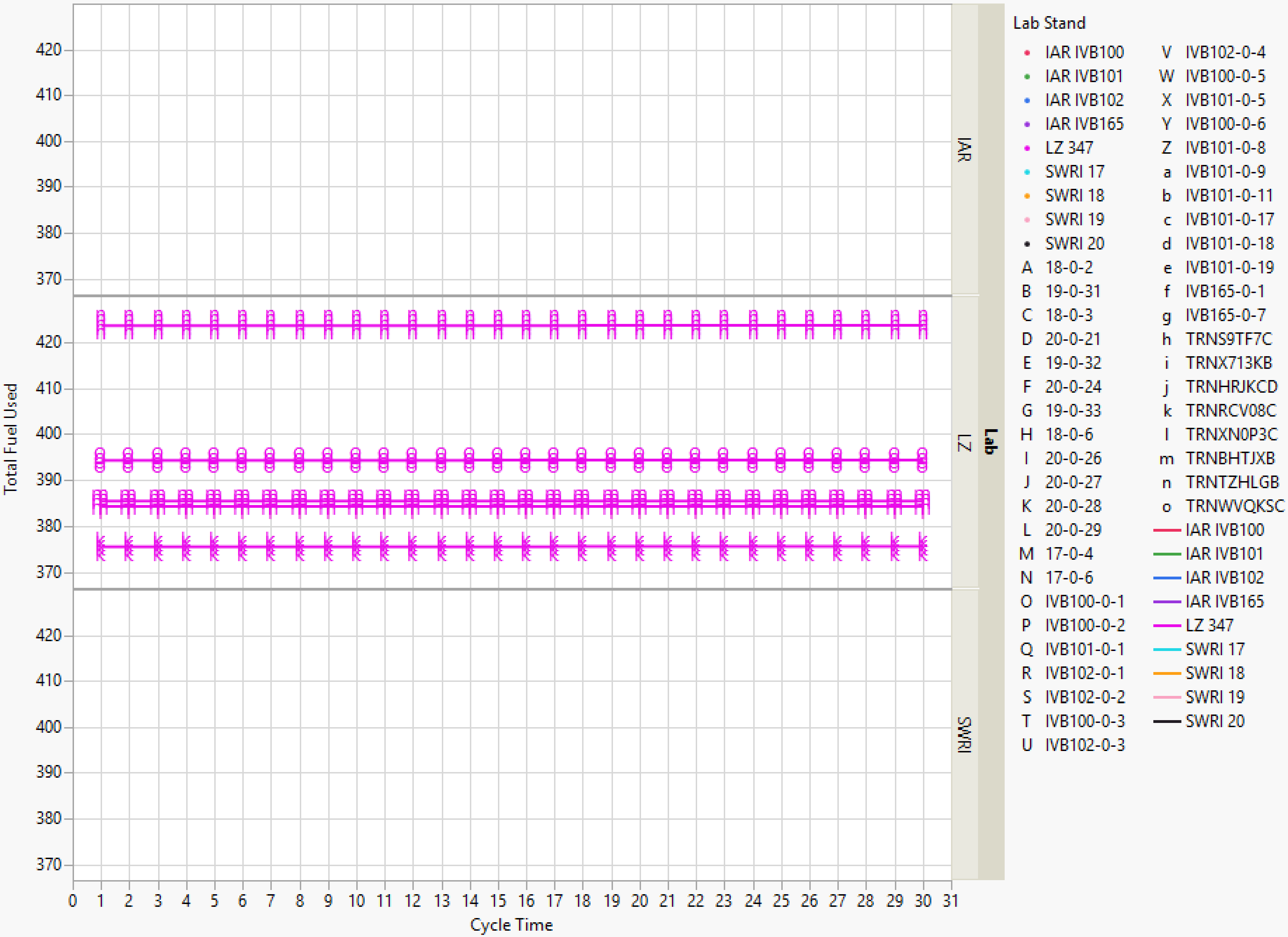


Lab Test
Final Prove-out tests
No
Yes
Test Cell Air Temperature
Cycle Time
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
36
32
28
24
20
4
10
16
22
28


Test Cell Air Temperature
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20



Lab Test
Final Prove-out tests
No
Yes
Total Fuel Used
Cycle Time
IAR IVB100-0-1
IAR IVB100-0-2
IAR IVB101-0-1
IAR IVB102-0-1
IAR IVB102-0-2
IAR IVB100-0-3
IAR IVB102-0-3
IAR IVB102-0-4
IAR IVB100-0-5
IAR IVB101-0-5
IAR IVB100-0-6
IAR IVB101-0-8
IAR IVB101-0-9
IAR IVB101-0-11
IAR IVB101-0-17
IAR IVB101-0-18
IAR IVB101-0-19
IAR IVB165-0-1
IAR IVB165-0-7
LZ TRNS9TF7C
LZ TRNX713KB
LZ TRNHRJKCD
LZ TRNRCV08C
LZ TRNXN0P3C
LZ TRNBHTJXB
LZ TRNTZHLGB
LZ TRNWVQKSC
SWRI 18-0-2
SWRI 19-0-31
SWRI 18-0-3
SWRI 20-0-21
SWRI 19-0-32
SWRI 20-0-24
SWRI 19-0-33
SWRI 18-0-6
SWRI 20-0-26
SWRI 20-0-27
SWRI 20-0-28
SWRI 20-0-29
SWRI 17-0-4
SWRI 17-0-6
425
410
395
380
4
10
16
22
28


Total Fuel Used
Cycle Time
IAR
LZ
SWRI
Lab
Lab Stand
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20
A 18-0-2
B 19-0-31
C 18-0-3
D 20-0-21
E 19-0-32
F 20-0-24
G 19-0-33
H 18-0-6
I 20-0-26
J 20-0-27
K 20-0-28
L 20-0-29
M 17-0-4
N 17-0-6
O IVB100-0-1
P IVB100-0-2
Q IVB101-0-1
R IVB102-0-1
S IVB102-0-2
T IVB100-0-3
U IVB102-0-3
V IVB102-0-4
W IVB100-0-5
X IVB101-0-5
Y IVB100-0-6
Z IVB101-0-8
a IVB101-0-9
b IVB101-0-11
c IVB101-0-17
d IVB101-0-18
e IVB101-0-19
f IVB165-0-1
g IVB165-0-7
h TRNS9TF7C
i TRNX713KB
j TRNHRJKCD
k TRNRCV08C
l TRNXN0P3C
m TRNBHTJXB
n TRNTZHLGB
o TRNWVQKSC
IAR IVB100
IAR IVB101
IAR IVB102
IAR IVB165
LZ 347
SWRI 17
SWRI 18
SWRI 19
SWRI 20

SUCCESS TOGETHER

Working together, achieving great things

When your company and ours combine energies, great things can happen. You bring ideas, challenges and opportunities. We'll bring powerful additive and market expertise, unmatched testing capabilities, integrated global supply and an independent approach to help you differentiate and succeed.