Sequence IV Surveillance Panel | MINUTES

REVISION DATE: 4/3/2018 10:44:00 AM

Relevant Test:	Sequence IVB
Note Taker:	Chris Mileti
Meeting Date:	03-01-2018
Comments:	Sequence IV Surveillance Panel conference call to discuss the ongoing analysis of the Precision Matrix data.

1. OPENING DISCUSSION:

1.1. Comments by Chairman (Buscher):

1.1.1. The agenda items sent out prior to this meeting will be covered during two conference calls (03-01-2018 and 03-07-2018).

1.1.1.1. There is too much material to discuss during a single conference call.

1.1.2. ***Agenda Items:***

1.1.2.1. Review additional Sequence IVB prove-out test results that have been generated since the end of the Precision Matrix.

1.1.2.2. Review two recent presentations compiled by the Statistics Group.

1.1.2.2.1. The first presentation correlates operational parameters to severity.

1.1.2.2.2. The second presentation reviews the latest samples of 1-hour operational data (10-11 hours and 195-196 hours) submitted by each laboratory.

1.1.2.2.3. Buscher encouraged all Surveillance Panel members to review the operational data that is posted on the TMC website.

1.2. Recent "Poor" Proof-of-Performance Tests:

1.2.1. Buscher stated that there are rumors that additive companies and oil marketers are running oils specifically formulated to generate failing results on the IVB test.

1.2.2. ***Lubrizol:***

1.2.2.1. Lubrizol confirmed that they have completed one "poor" proof-of-performance test on LZ347.

1.2.2.2. The "poor" oil was developed in the mid-2000's to generate excessive wear on the Sequence IVA test.

1.2.2.3. Intertek is currently running a repeat IVB test with the "poor" Lubrizol formulation.

1.2.3. ***Southwest:***

1.2.3.1. SWRI ran another prove-out test with REO1011 to evaluate stand repeatability.

1.2.3.2. This original Precision Matrix test generated a result of 1.46mm^3, and the repeat prove-out test generated a result of 1.27mm^3.

1.2.4. ***Exxon:***

1.2.4.1. They formulated a "poor" oil that was specifically designed to generate excessive wear on the Sequence IVB.

1.2.4.2. They completed two tests with this oil on their internal stand.

1.2.5. ***Afton:***

1.2.5.1. Afton has completed two prove-out tests on their new IVB stand.

1.2.5.2. They achieved a result of 2.4mm^3 with REO300, and a result of 1.04mm^3 with REO1012.

1.2.5.3. Buscher noted that Afton's volume loss, mass loss and iron align with the Precision Matrix tests that demonstrated similar severity levels.

1.2.5.4. Afton shut down one of the tests around 25HRS to recalibrate a few operational parameters.

1.2.5.4.1. The parameters operated correctly after the recalibration.

1.2.6. ***Intertek:***

1.2.6.1. *IAR165 History:*

1.2.6.1.1. IAR165 delivered unusually mild results through 2015.

1.2.6.1.2. The mild trend appears to have been the result of unusually warm ambient conditions around the test stand.

1.2.6.1.3. This stand was not used during the Precision Matrix.

1.2.6.2. IAR recently completed two prove-out tests on IAR165.

1.2.6.2.1. Test #1 (REO300): 2.26mm^3 and 328ppm E.O.T. iron

1.2.6.2.2. Test #2 (REO1012): 1.06mm^3 and 86ppm E.O.T. iron

1.2.6.2.3. These two test results were given to the Statistics Group, but they have not been included in their analysis.

1.2.7. Buscher asked the Statistics Group to compare the available data from the recent proof-of-performance tests to the Precision Matrix data.

1.3. Oil Samples:

1.3.1. The Surveillance Panel previously requested that each development laboratory send oil samples from their Precision Matrix tests to IAR.

1.3.1.1. Afton was asked to send oil samples from their prove-out tests because they did not participate in the Precision Matrix.

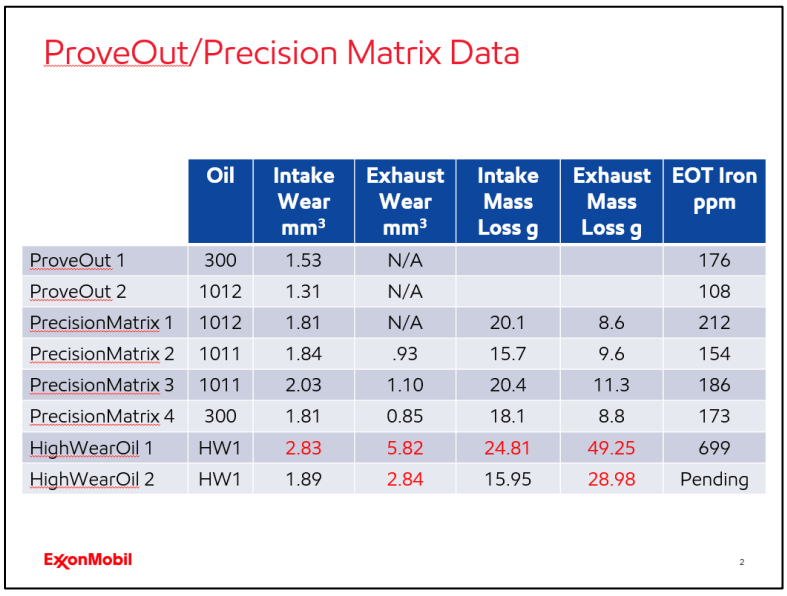
1.3.2. IAR will repeat the analysis of each sample to eliminate laboratory bias.

1.3.3. SWRI, Afton and Lubrizol have provided their samples to IAR.

1.3.4. The Exxon samples are on the way to IAR.

2. EXXON PRESENTATION ON "POOR" PROOF-OF-PERFORMANCE TESTING:

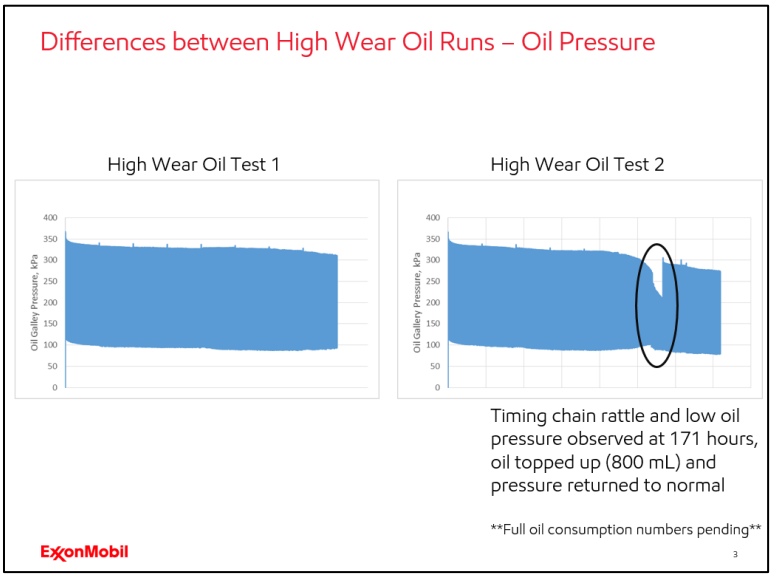
2.1. Slide #2:

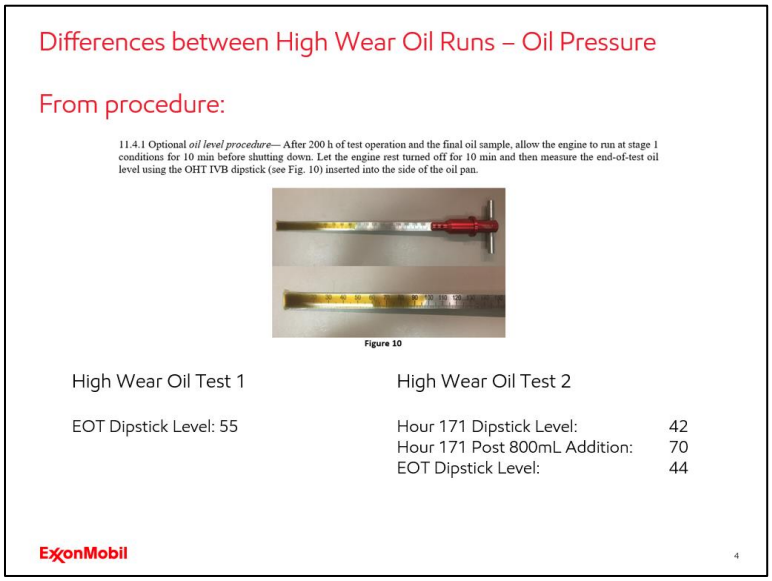


	Oil	Intake Wear mm^3	Exhaust Wear mm^3	Intake Mass Loss g	Exhaust Mass Loss g	EOT Iron ppm
ProveOut 1	300	1.53	N/A			176
ProveOut 2	1012	1.31	N/A			108
PrecisionMatrix 1	1012	1.81	N/A	20.1	8.6	212
PrecisionMatrix 2	1011	1.84	.93	15.7	9.6	154
PrecisionMatrix 3	1011	2.03	1.10	20.4	11.3	186
PrecisionMatrix 4	300	1.81	0.85	18.1	8.8	173
HighWearOil 1	HW1	2.83	5.82	24.81	49.25	699
HighWearOil 2	HW1	1.89	2.84	15.95	28.98	Pending

2.1.1. Exxon reported wear results between 1.3mm^3 and 2.0mm^3 during the Precision Matrix.
2.1.2. Their formulators expected their high wear oil to generate very severe average intake lifter volume loss results.
2.1.3. ***Initial Test with High Wear Oil:***
2.1.3.1. *Average Intake Lifter Volume Loss* = 2.83mm^3
2.1.3.2. *Average Exhaust Lifter Volume Loss* = 5.82mm^3
2.1.3.3. *End of Test Iron* = 699ppm
2.1.3.4. The exhaust lifters had one of the highest volume loss measurements ever recorded for the IVB test.
2.1.4. ***Repeat Test with High Wear Oil:***
2.1.4.1. Exxon ran a second test with the exact same oil.
2.1.4.2. They do not yet have any ICP results because the test just completed.
2.1.4.3. *Average Intake Lifter Volume Loss* = 1.89mm^3
2.1.4.4. *Average Exhaust Lifter Volume Loss* = 2.84mm^3

2.2. Slides #3 and #4:

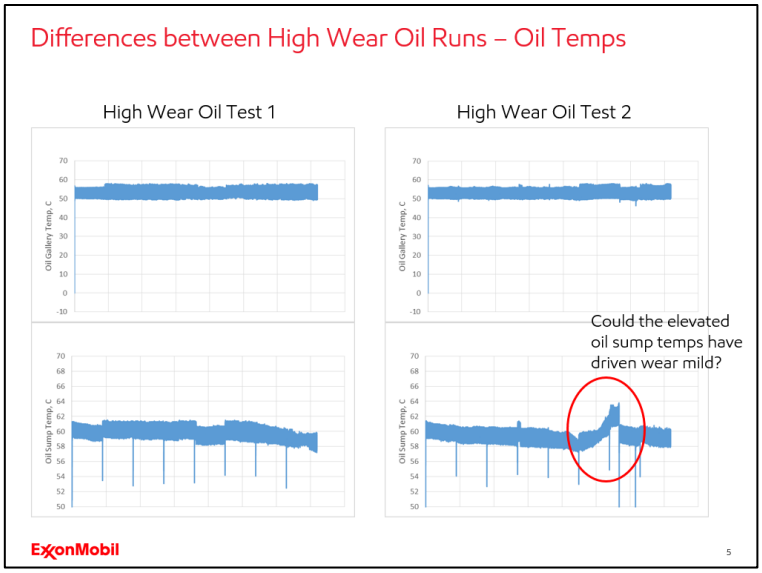




2.2.1. Exxon's repeat test with the high wear oil had operational problems that were caused by excessive oil consumption.

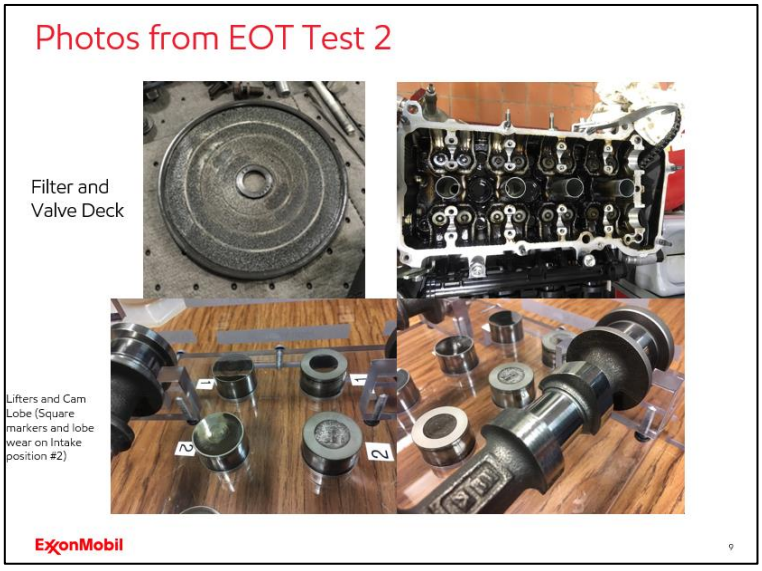
2.2.2. They were first alerted to these problems by timing chain rattle and low oil pressure.
2.2.3. The dipstick level around 171HRS was 40mm.
2.2.4. They added 800mL of fresh oil.
    2.2.4.1. The dipstick level increased to 70mm.
    2.2.4.2. This eliminated the rattle and allowed the oil pressure to recover.
    2.2.4.3. However, the unscheduled addition probably biased the end-of-test results.

2.3. Slide #5:



2.3.1. It is not clear whether the additional 800mL of fresh oil altered the fuel and/or water dilution.
2.3.2. The excessive oil consumption caused a corresponding increase in oil sump temperature.
    2.3.2.1. Exxon: *Could the elevated oil sump temperature (+4.0°C) have caused the final wear result to shift "mild"?*

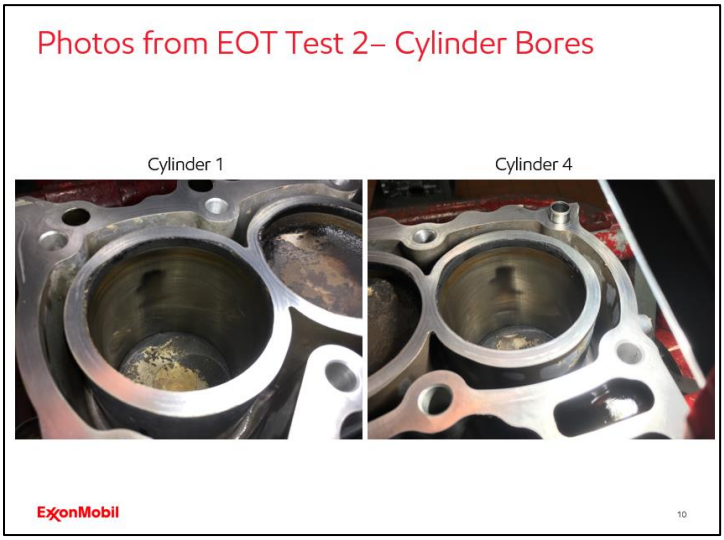
2.4. Slide #9:



2.4.1. "Test 2" was the repeat run on the Exxon high wear oil.
    2.4.1.1. This was the 6th run on the engine.

2.4.1.2. This engine was <u>not</u> used during the Precision Matrix.
2.4.2. Intake lifter #2 had a square-shaped mark on its wear surface.
2.4.2.1. This is an indication that the lifter stopped rotating at some point during the test.
2.4.3. The Oberg filter was covered in metal particles.
2.4.4. ***Comments from Intertek and Lubrizol:***
2.4.4.1. Lubrizol and IAR looked closely at the camshaft photographs in Exxon's presentation.
2.4.4.2. Both labs believe that Exxon suffered a camshaft lobe failure (intake lobe #2).
2.4.5. ***Comments from Afton:***
2.4.5.1. *Where did the oil go?*
2.4.5.2. Exxon stated that the engine block had distinct bore polishing.
2.4.5.2.1. The oil was probably burned.
2.4.6. ***Comments from Lubrizol:***
2.4.6.1. *What is the black deposit on the valve deck?*
2.4.6.2. Lubrizol has not seen this type of deposit/discoloration before.
2.4.6.3. Exxon stated that this oil was formulated to deliver an extremely severe result on the IVB test.
2.4.6.4. IAR speculated that the black deposit was related to something unique in the Exxon formulation.
2.4.7. ***Varnish Around Lifter Perimeter:***
2.4.7.1. IAR noted that lifter #1 had a varnish deposit around its perimeter.
2.4.7.2. *Comments from Lubrizol:*
2.4.7.2.1. Lubrizol has seen this type of perimeter deposit on its internal test kits.
2.4.7.2.2. This deposit can sometimes feel sticky to the touch.
2.4.7.2.3. Lubrizol theorized that this deposit could be inhibiting lifter rotation.

2.5. Slide #10:



2.5.1. IAR asked if the dark region in the ring reversal area is varnish or excessive wear.
2.5.1.1. Exxon will need to have a closer look at the engine block before they can answer that question.
2.5.2. Exxon speculated that the two camshafts in the IVB test may be experiencing different wear mechanisms.
2.5.3. The intake camshaft may be experiencing more corrosive wear than the exhaust camshaft.

2.5.3.1. The amount of corrosive wear was probably reduced by the higher blowby temperature set-point and revised fuel sulfur specification.
2.5.3.2. The corrosive wear is probably being made worse by the hard line on in the interior of the rocker arm cover.
2.5.3.2.1. This hard line causes emulsion to drip directly onto the intake lifters.
2.5.4. Higher temperatures on the exhaust side of the engine may be contributing to more "traditional" wear on the exhaust camshaft.
2.5.5. IAR asked Exxon to confirm that stock valve springs are being used on the exhaust side of the engine.
2.5.5.1. Exxon already checked this, but they offered to confirm it again.
2.5.6. Lubrizol will copy Exxon's report format to document its two recent "poor" proof-of-performance tests.
2.5.7. ***Follow-up Items for Exxon Regarding the 2nd High Wear Oil Test:***
2.5.7.1. Inspect ring reversal area for signs of varnish.
2.5.7.2. End-of-test iron
2.5.7.3. End-of-test oil consumption
2.5.7.4. Inspect lifters for perimeter deposits
2.5.7.5. NOACK of "poor" proof-of-performance oil
2.5.7.6. Confirm that high-tension valve springs were used on intake side only.

2.6. Toyota's Comments:

2.6.1. The Sequence IVB test typically encounters an increase in iron between 150 and 200HRS.
2.6.1.1. Exxon added fresh oil to their 2nd test during this time interval (~171HRS).
2.6.1.2. Exxon's 2nd test delivered a milder result than their 1st test because the new oil addition slowed down the rate of lifter wear during a critical time.
2.6.2. Toyota would like to see how the rate of iron generation changed after the fresh oil was added.

2.7. Proposed Iron Limit:

2.7.1. The 1st high wear oil test at Exxon delivered an end-of-test iron of 699ppm.
2.7.1.1. Intertek noted that the high exhaust lifter wear most likely contributed to the high end-of-test iron.
2.7.2. ***Comments from Infineum:***
2.7.2.1. Chemistry like the Exxon high wear oil should obviously not be in a commercial formulation.
2.7.2.2. They proposed adding an iron limit to the test in addition to the average intake lifter volume loss parameter.
2.7.2.2.1. Toyota stated that they are already considering this.

2.8. Engine Life:

2.8.1. Intertek recently used an engine for (9) runs.
2.8.1.1. This engine began to experience high oil consumption on the 9th run.
2.8.1.2. The 9th run used a 0W-8 oil.
2.8.1.3. This engine was decommissioned after the 9th run [even though IAR intended to use it for (12) runs].
2.8.2. Intertek is still seeing a lot of cylinder bore polishing and ring wear with decommissioned engines.

3. LUBRIZOL SPREADSHEET ON "POOR" PROOF-OF-PERFORMANCE TESTING:

3.1. Background on "Poor" Proof-of-Performance Oil:

3.1.1. This oil was developed as a baseline formulation for an internal wear study that Lubrizol conducted in the mid-2000's.

3.1.1.1. Much of the testing for this wear study was done on Lubrizol's internal Sequence IVA test stand.

3.1.1.2. The "poor" proof-of-performance oil yielded a result of approximately 260µm on the Sequence IVA.

3.2. Sequence IVB Testing:

3.2.1. Lubrizol tested its "poor" proof-of-performance oil on its internal Sequence IVB test stand (LZ347).

3.2.2. Lubrizol used its Precision Matrix engine for this testing (along with Batch-D camshafts).

3.2.3. All the QI's were positive except for the intake air temperature.

3.2.3.1. The test stand was run for several hours with the intake air temperature outside of limits.

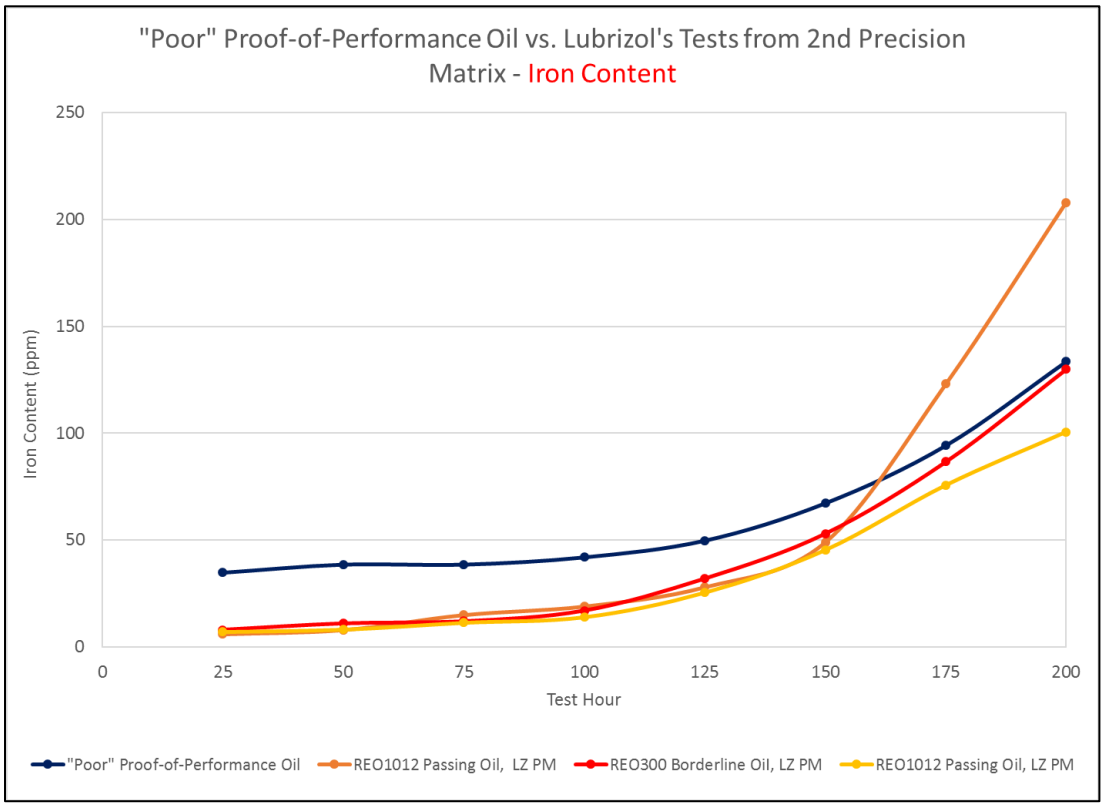
3.2.3.2. The test engineer made the decision to keep running the stand under these conditions so that the results would be available as soon as possible.

3.2.4. ***Summary of Results:***

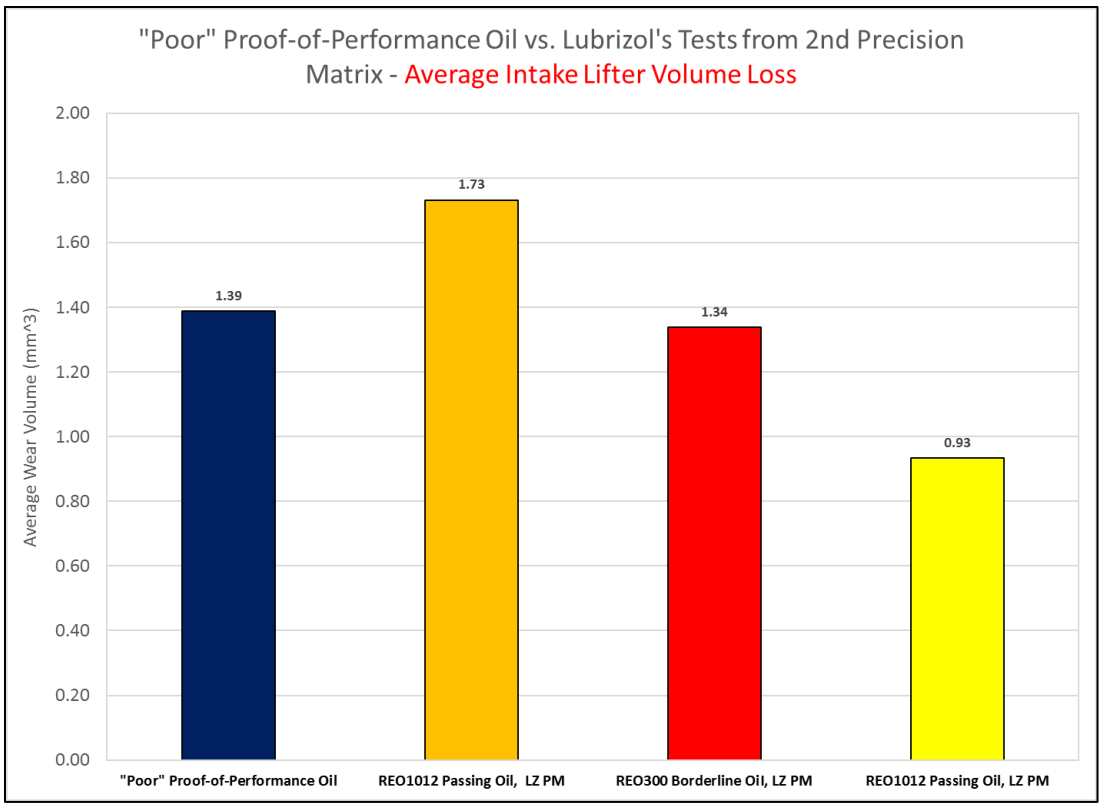
3.2.4.1. Lubrizol's "poor" proof-of-performance oil generated intake lifter volume loss and end-of-test iron measurements that were within the range of results from its two REO1012 Precision Matrix tests.

3.2.4.2. REO1012 is the "passing" reference oil.

3.2.5. ***Iron Curve:***



3.2.6. ***Average Intake Lifter Volume Loss:***



3.2.7. ***Repeat Test at Intertek:***

3.2.7.1. IAR is running a repeat of the Lubrizol "poor" proof-of-performance test.

3.2.7.2. IAR is using one of their Precision Matrix engines to test this oil.

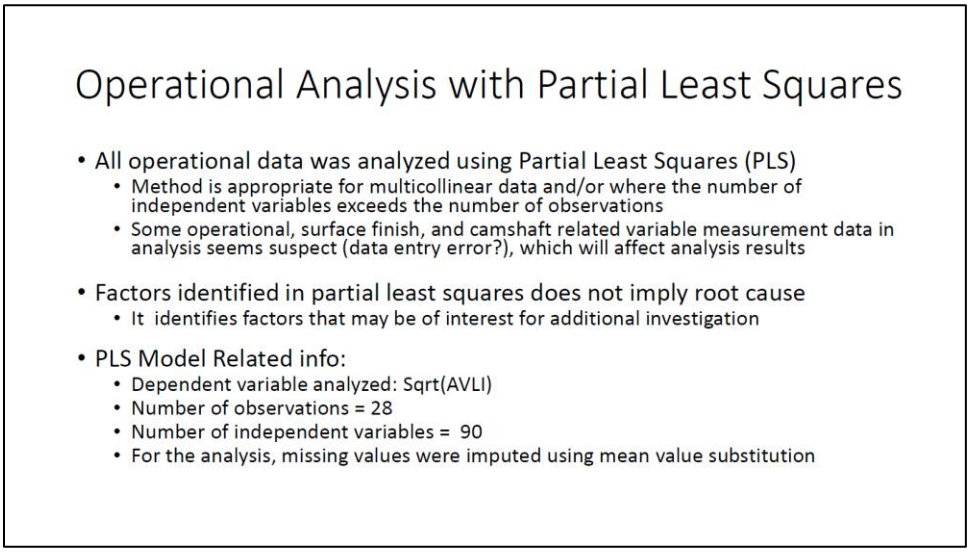
3.2.7.3. The 150HR iron concentration for the Intertek test is 65ppm.

3.2.7.3.1. The 150HR iron concentration for the original Lubrizol test was 67ppm.

3.2.7.3.2. It is likely that the IAR result will match the Lubrizol result.

4. SEQUENCE IVB OPERATIONAL ANALYSIS (STATISTICS GROUP, REVISED 02-14-2018):

4.1. Slide #2:



4.1.1. There are more variables than observations.
4.1.2. The statisticians warned that there may be some erroneous data in the files posted to the TMC website.
4.1.2.1. They did not attempt to change or revise any of this data.
4.1.2.2. Their analysis was conducted on the data in its current form.

4.2. Slide #3:

Operational Analysis with Partial Least Squares

- Excluding lab-Stand & oil factors, the top 20 variables identified in the PLS analysis of the Sqrt(AVLI) are summarized below:

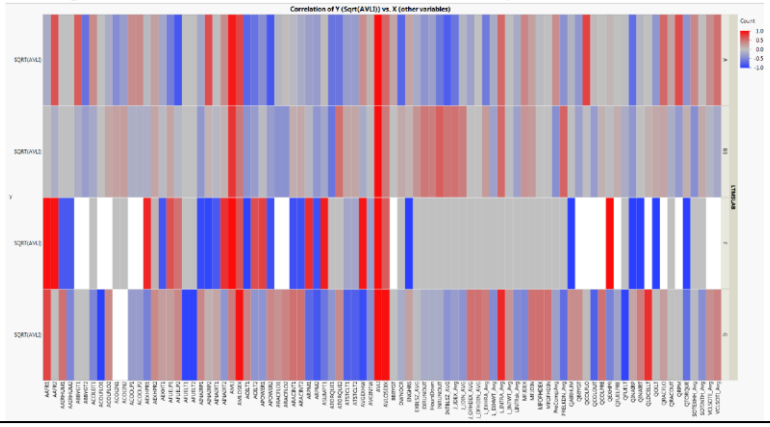
	Top 20 Factors	Variable Description
1	INRUNOUT	Intake Camshasft Runout
2	L_INTRA_Avg	Lobe Intake Surface Finish Average Ra
3	EXRUNOUT	Exhaust Camshaft Runout
4	DWNOCR	Number of Downtime Occurrences
5	ARPM2	Average RPM - Phase 2
6	AAFR2	Avg Air/Fuel Ratio Phase 2
7	J_JDIN_AVG	Journal to Journal Dia Intake Avg
8	QOILT	EOT QI Oil Gallery Temp
9	PreCompAvg	Average Cyl Compression PreTest
10	EXBLSZ_AVG	Exhaust Lifter Bucket Size Average
11	J_JDEX_Avg	Journal to Journal Dia Exhaust Avg
12	ATORQUE1	Average Torque Phase 1
13	ACOOLP2	Average Engine Coolant Pressure Stage 2
14	ACOOLP1	Average Engine Coolant Pressure Stage 1
15	AFUELP2	Average Fuel Pressure Phase 2
16	SOTINTH_Avg	Start of Test Heel to Toe Intake Avg
17	MFJDEX	Main Feed Oil Hole Dia, Exhaust Cam
18	AINAIRT2	Avg Intake Air Temp Phase 2
19	QAIRHUM	EOT QI Intake Air Humidity
20	INTBLSZ_AVG	Avg Intake Bucket Lifter Size

4.2.1. This analysis excluded lab, stand and oil influences.
4.2.2. The statisticians identified the Top-20 variables that correlate to test severity.
4.2.2.1. Some of these are "composite" variables that are not available in the data dictionary.
4.2.3. Some of these variables, such as ***#9 – Average Cylinder Compression PreTest***, are confounded by engine hours.

4.3. Slide #4:

Operational Analysis with Partial Least Squares

- A color heat map of the correlations between the Sqrt(AVLI) and the other remaining variables are summarized below - by test lab:



4.3.1. The color indicates the level of correlation.
4.3.1.1. Red shows a positive correlation.
4.3.1.2. Blue shows a negative correlation.
4.3.2. The variables are listed on the x-axis.

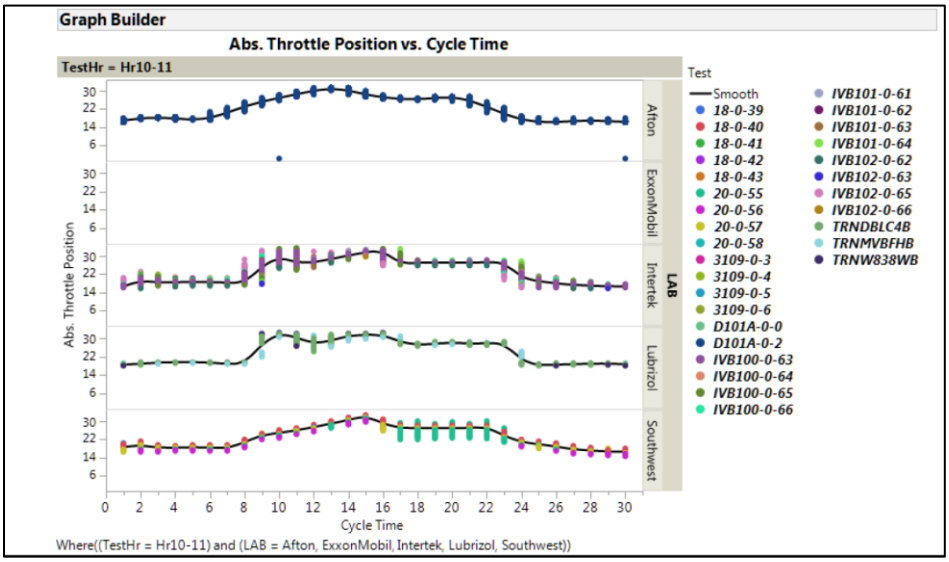
4.4. Discussion:

4.4.1. The statisticians encouraged all the Surveillance Panel members to review the remaining graphs in this presentation.

4.4.2. Buscher would like to review member feedback during next week's conference call.

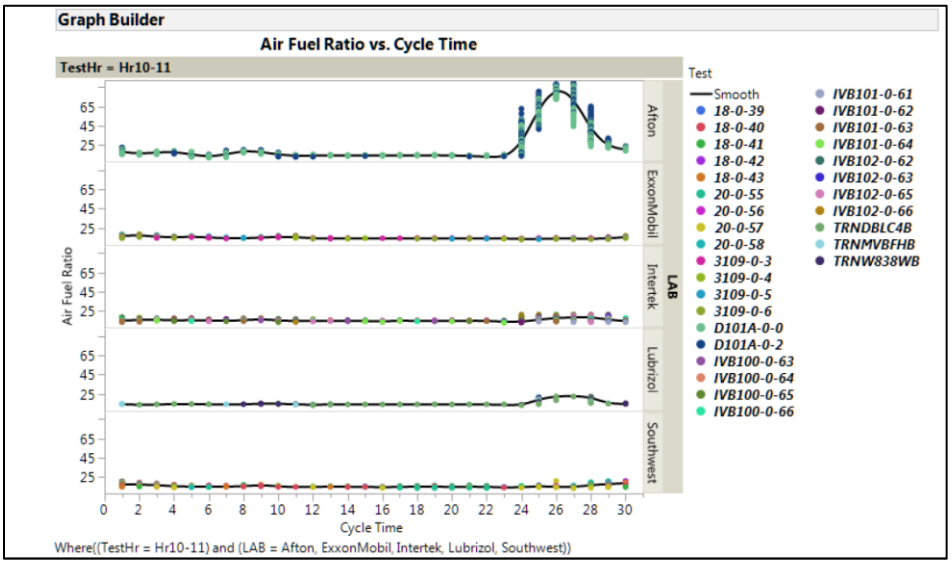
5. OPERATIONAL DATA REVIEW, 10HR-11HR SEGMENT:

5.1. Absolute Throttle Position:



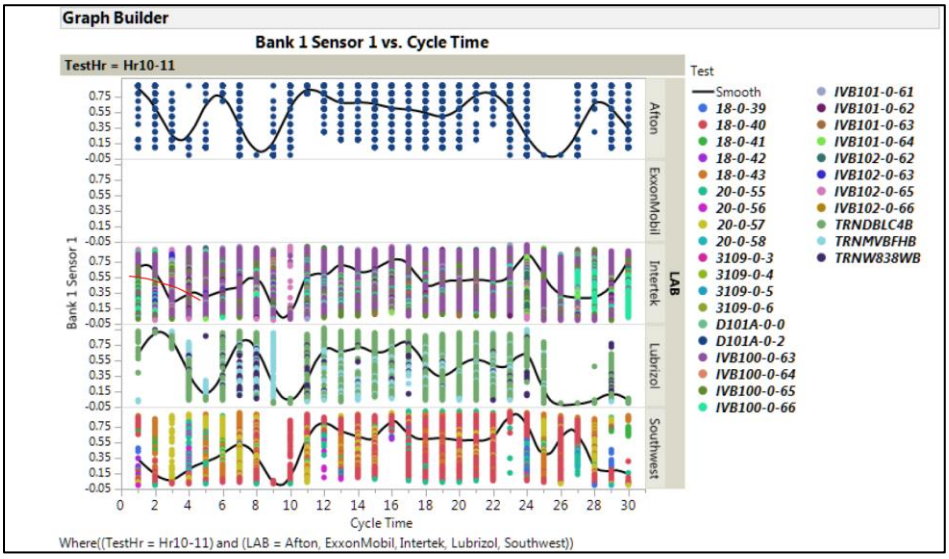
5.1.1. TMC noted that Afton is very similar to SWRI.

5.2. AFR:



5.2.1. Afton experienced a calibration issue that impacted their AFR magnitude near the end of each test cycle.

5.3. Bank 1, Sensor 1:

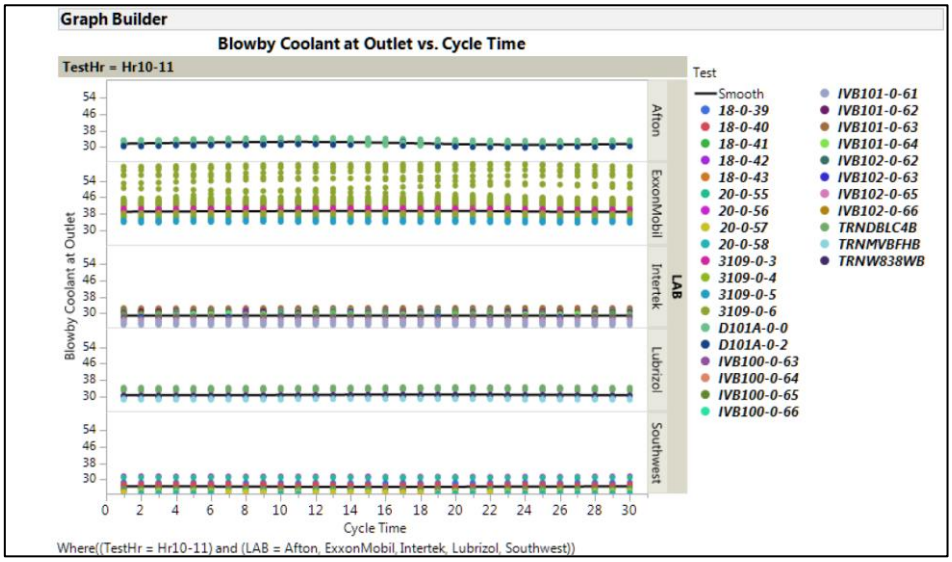


5.3.1. Lubrizol feels that there is too much noise in this parameter for it to be useful.

5.3.2. IAR and Toyota both believe that the data for this parameter appears to be normal.

5.3.2.1. Everything is functioning correctly if the magnitude of the measurement falls between 0-1.

5.4. Blowby Coolant at Outlet:



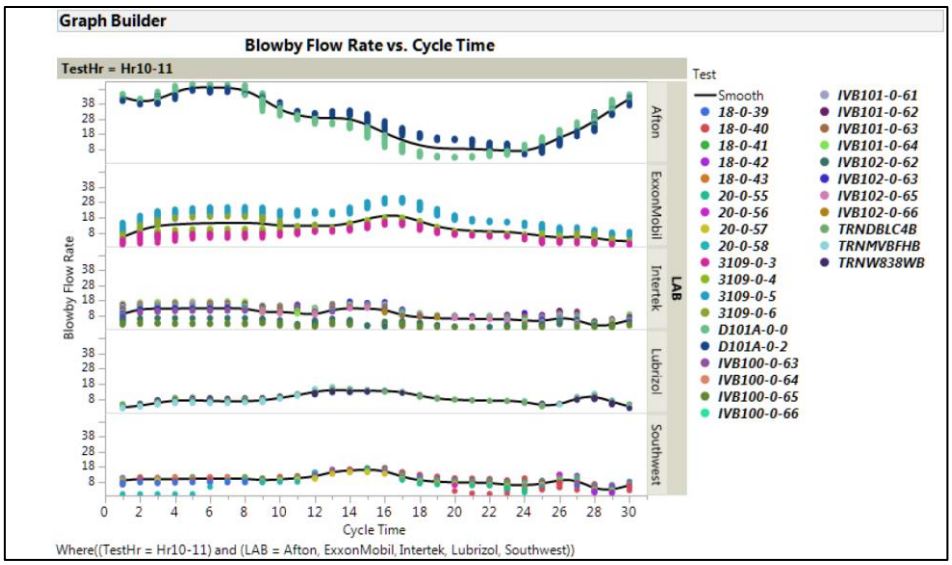
5.4.1. ***Comments from Exxon:***

5.4.1.1. Exxon is not using the circulation tank and external pump (that is being used at the other labs).

5.4.1.2. Instead, they are using a steam system.

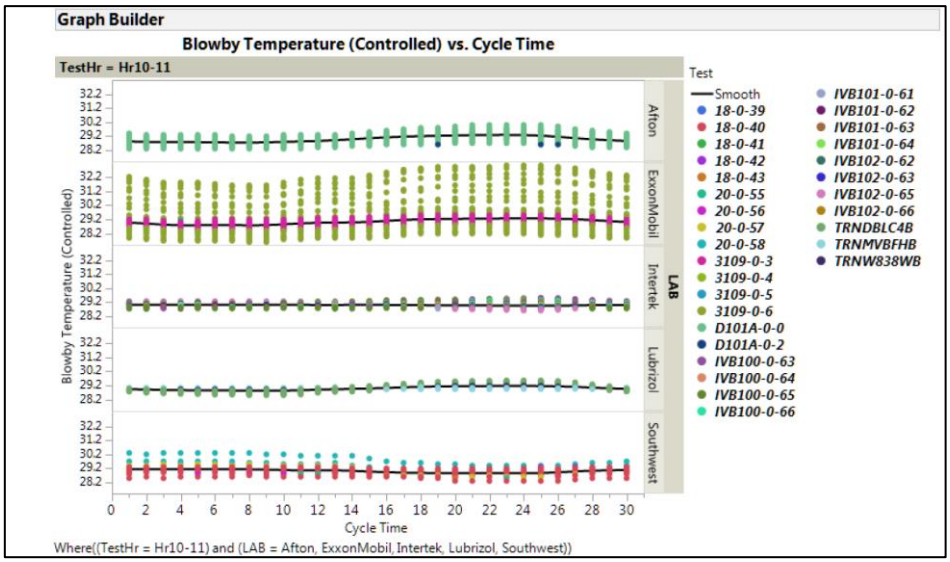
5.4.1.3. This may be why their data appears different than the data from the other labs.

5.5. Blowby Flow Rate:



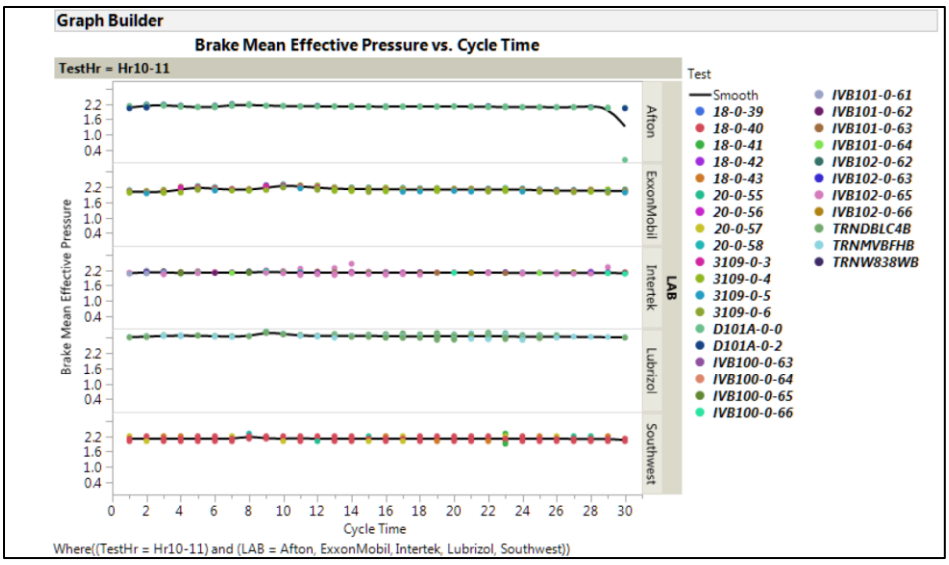
5.5.1. Lubrizol has the lowest blowby flow rate.
5.5.2. Afton has the highest blowby flow rate.

5.6. Blowby Temperature:



5.6.1. One of the Exxon tests had excessive noise in its blowby temperature measurement.
5.6.1.1. This noise was due to a steam issue that occurred near the beginning of the test.

5.7. Brake Mean Effective Pressure:

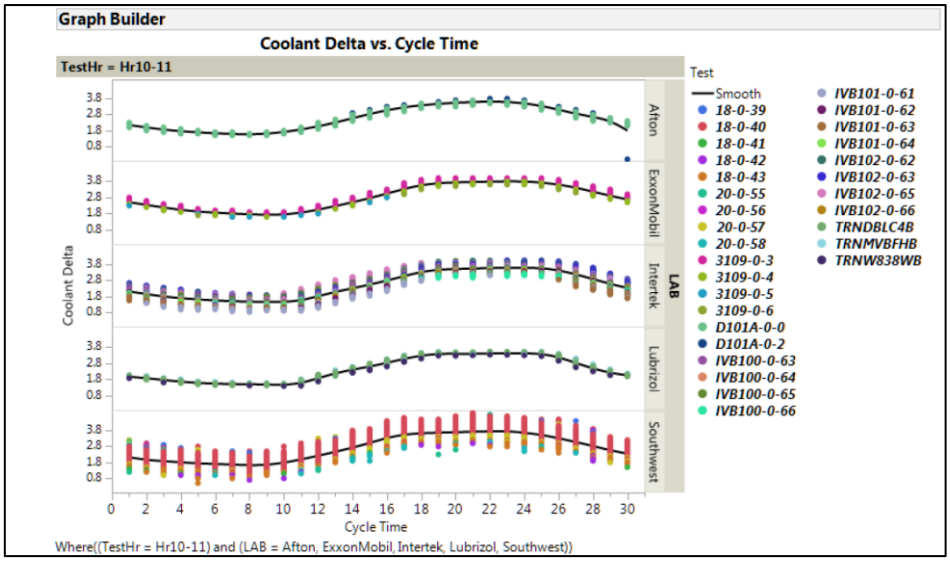


5.7.1. Lubrizol is not calculating this parameter correctly.

5.7.2. The Afton data shows an anomaly during the last several seconds of each cycle.

5.7.2.1. They had a data acquisition issue that prevented the last second of data from writing.

5.8. Coolant Delta:

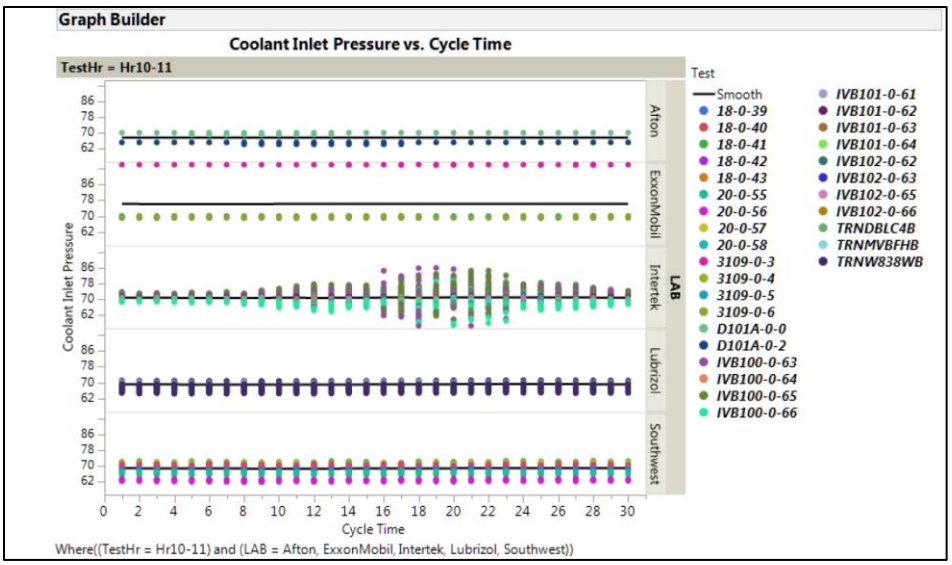


5.8.1. ***Comments from Intertek:***

5.8.1.1. The curves from each lab have similar shapes.

5.8.1.2. This is one parameter that has changed drastically over the course of test development.

5.9. Coolant Inlet Pressure:

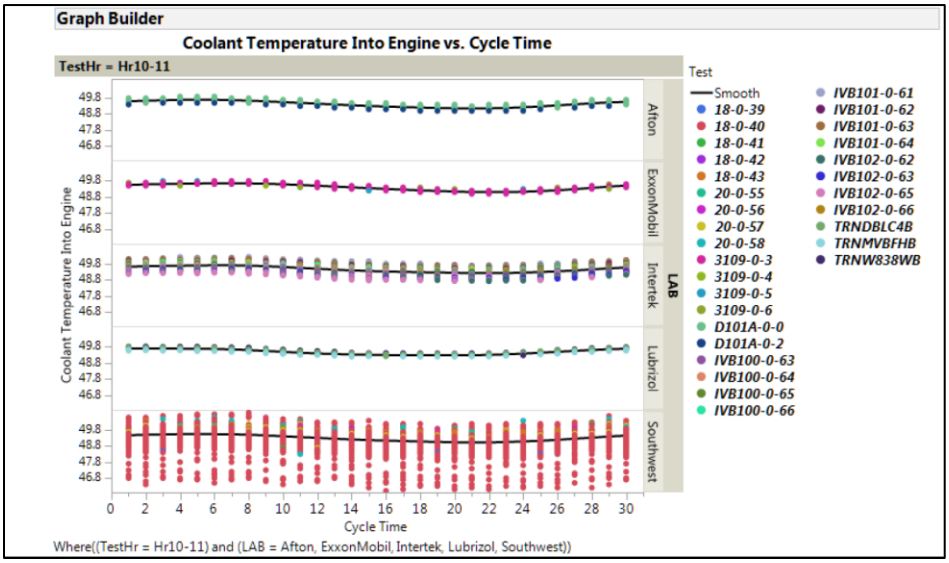


5.9.1. Exxon had a coolant pressure issue that was corrected early in the test.

5.9.2. Afton noted that the coolant pressure on the IAR stands becomes noisier as they enter Stage 2 conditions.

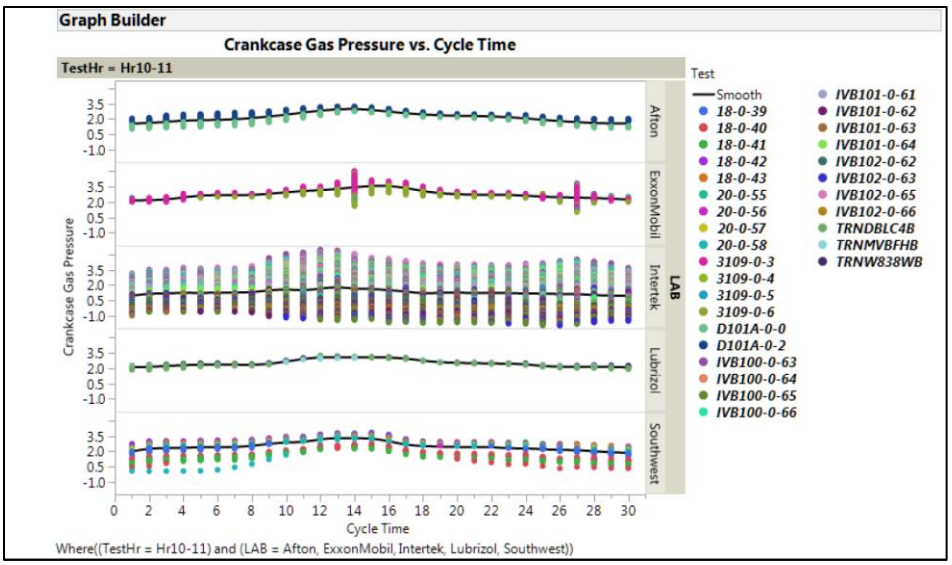
5.9.2.1. IAR will follow-up on this observation.

5.10. Coolant Temperature into Engine:



5.10.1. One of the tests at SWRI had a coolant temperature that was highly variable.

5.11. Crankcase Gas Pressure:

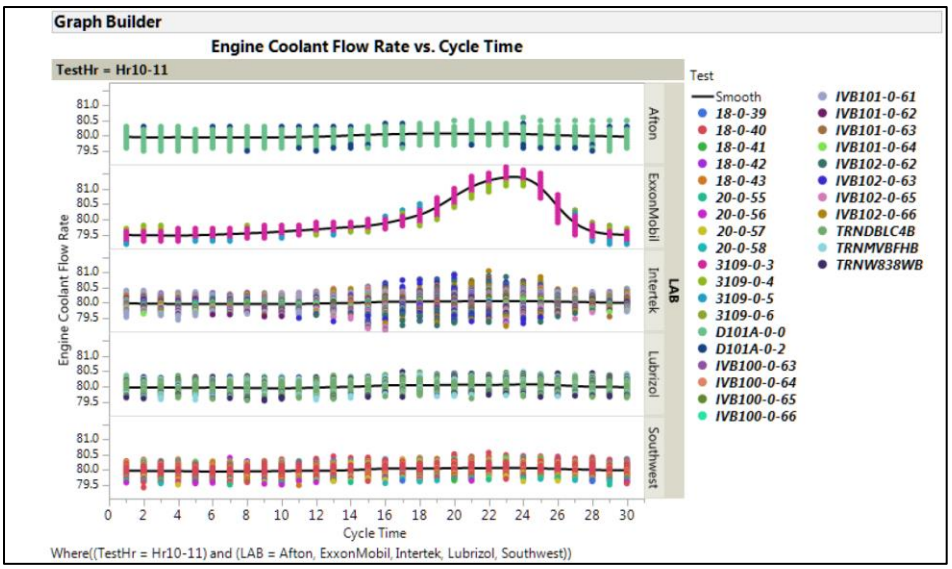


5.11.1. Lubrizol is concerned that the curves for IAR and SWRI look fundamentally different than those for the dependent labs.

5.11.2. IAR has a lot of variability in its crankcase pressure measurements.

5.11.2.1. Their crankcase pressure also drops much lower than the crankcase pressure at the other labs.

5.12. Engine Coolant Flow Rate:

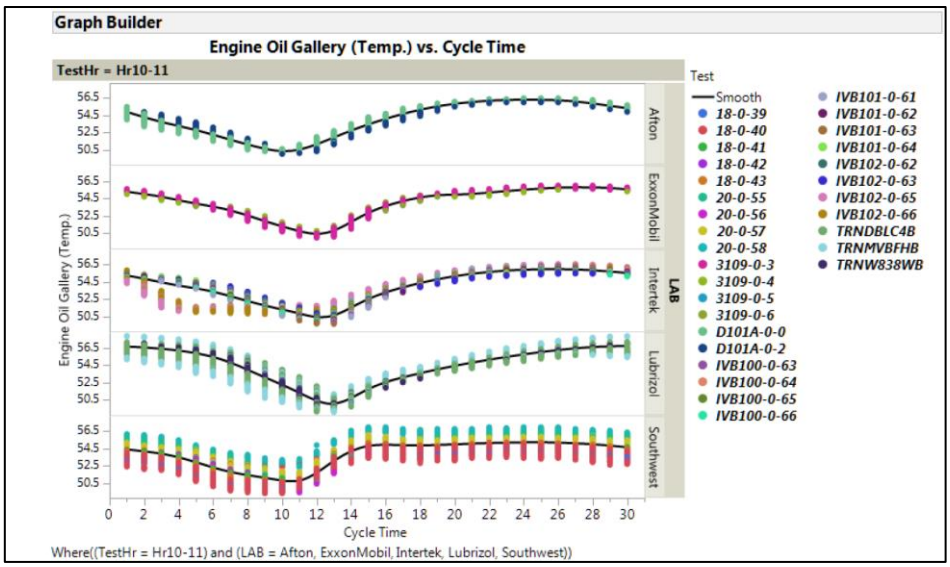


5.12.1. The unusual peak in the Exxon data (between 18-seconds and 28-seconds) was due to an internal leak in their heat exchanger.

5.12.1.1. They fixed this problem after the Precision Matrix.

5.12.1.2. This parameter has exhibited excellent control since the heat exchanger was replaced.

5.13. Engine Oil Gallery Temperature:



5.13.1. There are clear differences in the shape of the oil gallery temperature curves at each lab.

5.13.1.1. However, all the labs appear to have the same minimum and maximum oil temperatures.

5.13.2. All the labs are reaching their minimum oil temperature at different points in the 30-second test cycle.

5.13.3. ***Comments from TMC:***

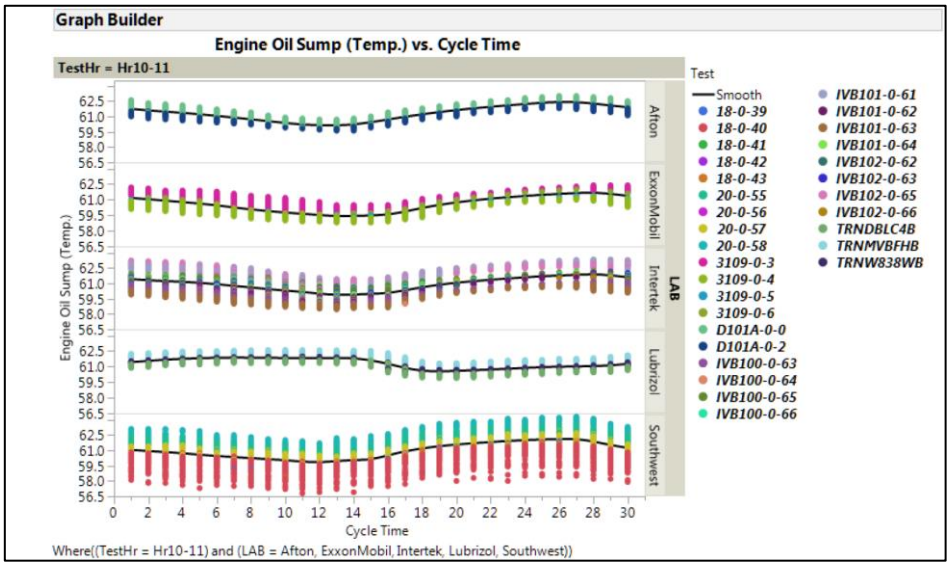
5.13.3.1. The recent analysis by the statisticians found a correlation between oil gallery temperature QI and test severity.

5.13.3.2. The temperature differences between labs may be significant.

5.13.4. Exxon questioned whether the differences in the temperature curves could be the result of time constant differences.

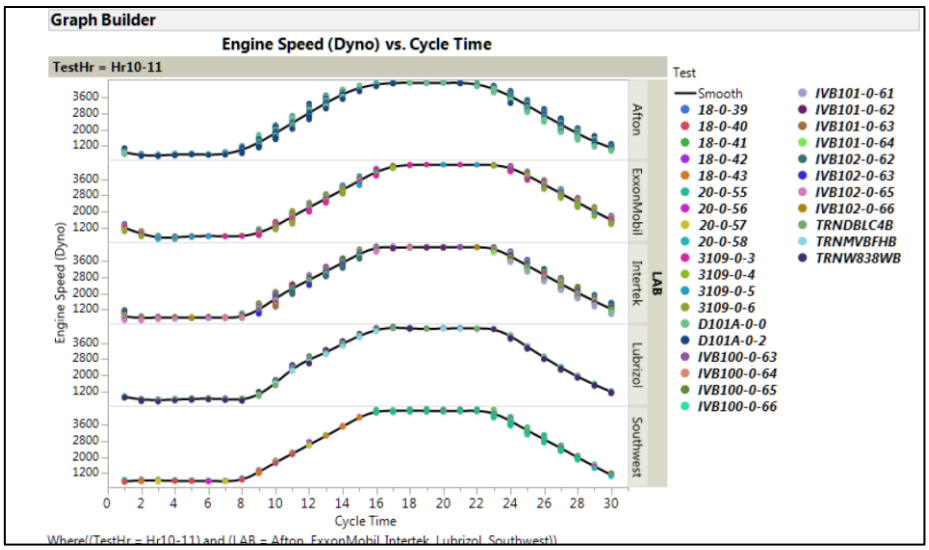
5.13.4.1. All five labs agreed to follow-up on this possible explanation.

5.14. Engine Oil Sump Temperature:



5.14.1. The oil sump temperature curves show the same differences (in shape) as the oil gallery temperature curves.

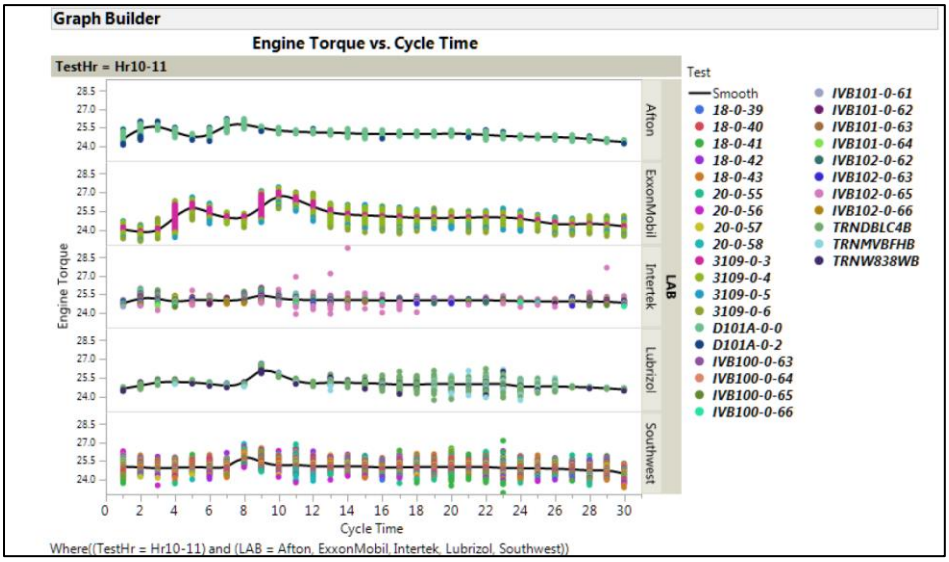
5.15. Engine Speed:



5.15.1. The Lubrizol stand still exhibits a small "bump" in speed at approximately 11-seconds into the test cycle.

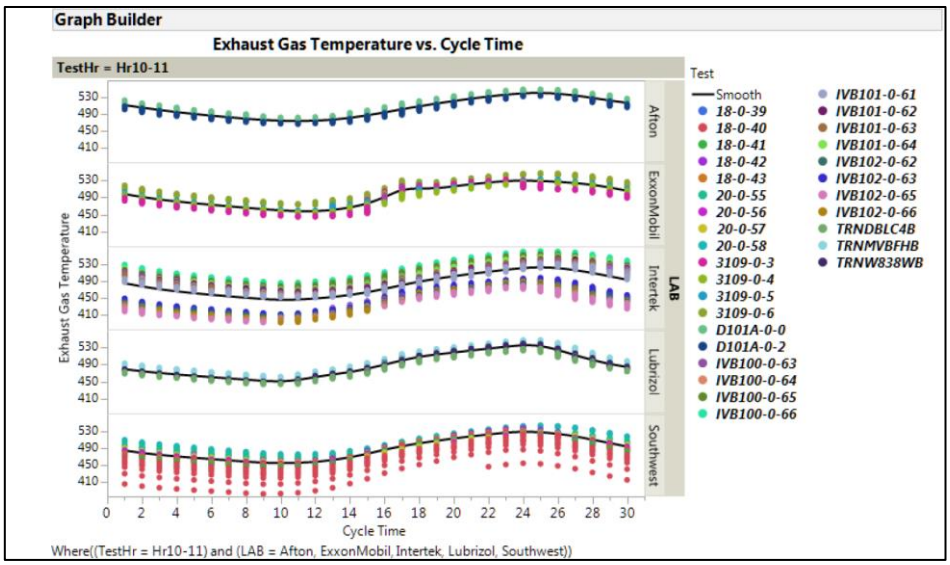
5.15.1.1. Lubrizol has been unable to explain or eliminate this anomaly.

5.16. Engine Torque:



5.16.1. Exxon has the largest "spikes" in torque.

5.17. Exhaust Gas Temperature:



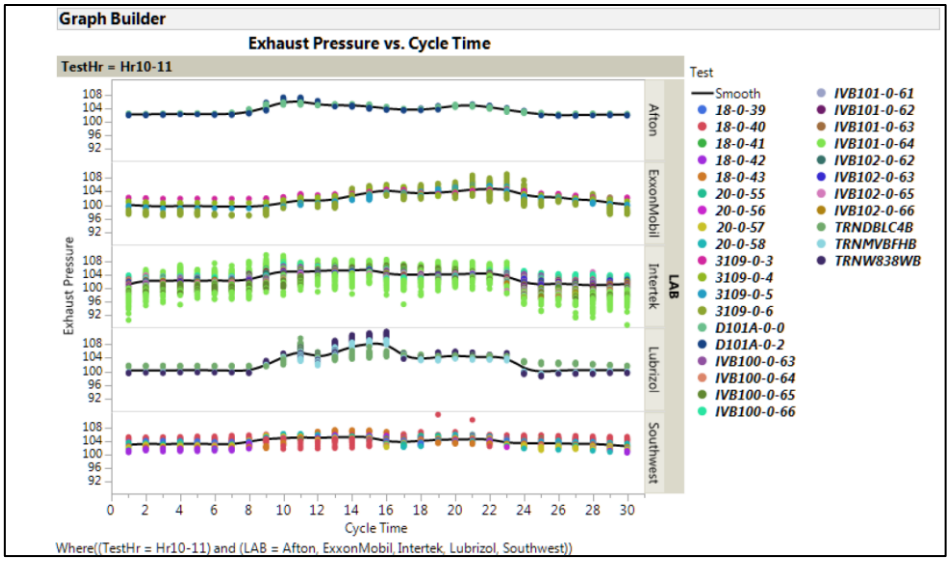
5.17.1. ***Comments from Intertek:***

5.17.1.1. Intertek recently changed several exhaust gas thermocouples on one of their test stands.

5.17.1.2. They found significant part-to-part variation in these thermocouples.

5.17.1.3. They believe that most of the lab-to-lab and stand-to-stand differences in this parameter are due to thermocouple variability.

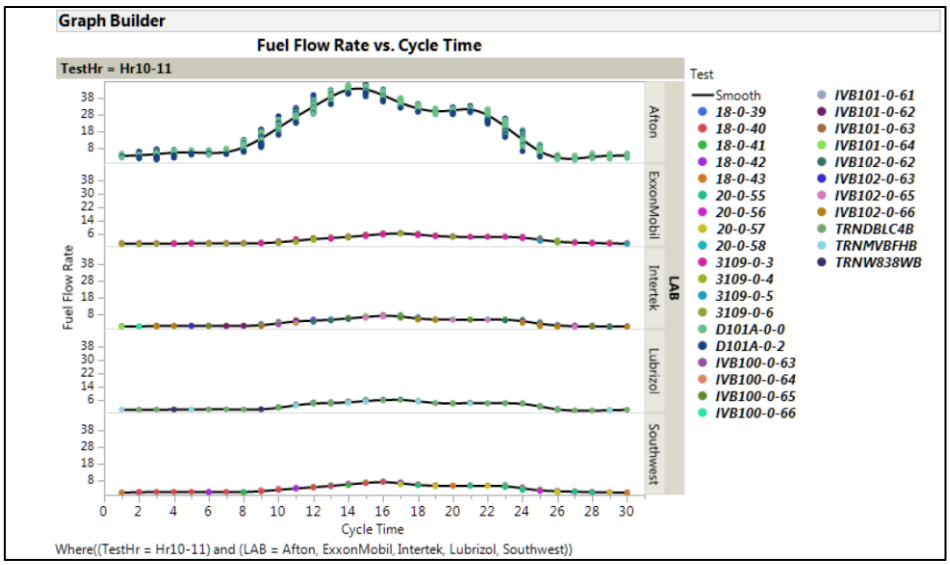
5.18. Exhaust Pressure:



5.18.1. Exxon recorded negative QI's for exhaust backpressure even though their data (when graphed) exhibited very good control around the set-point.

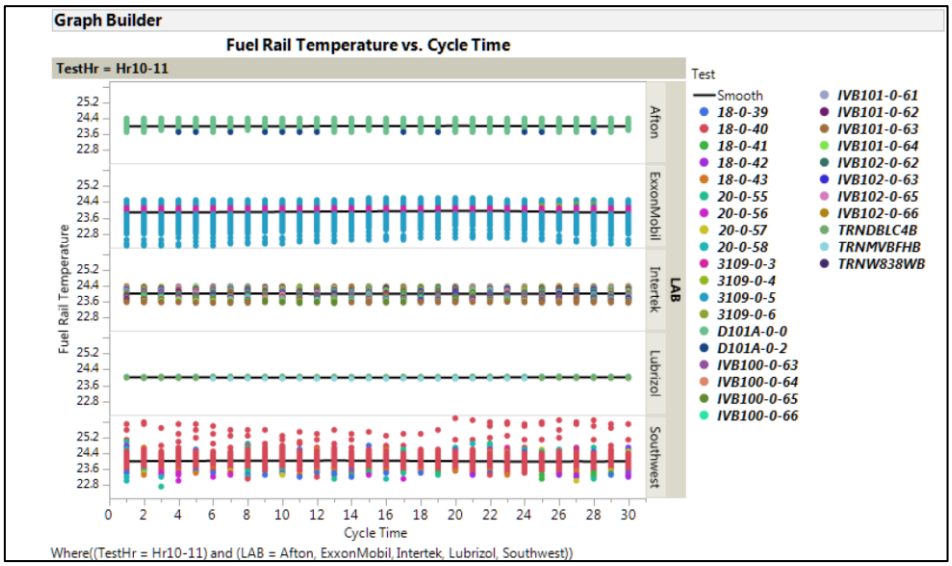
5.18.1.1. It is possible that they have a problem with the QI calculation.

5.19. Fuel Flow Rate:



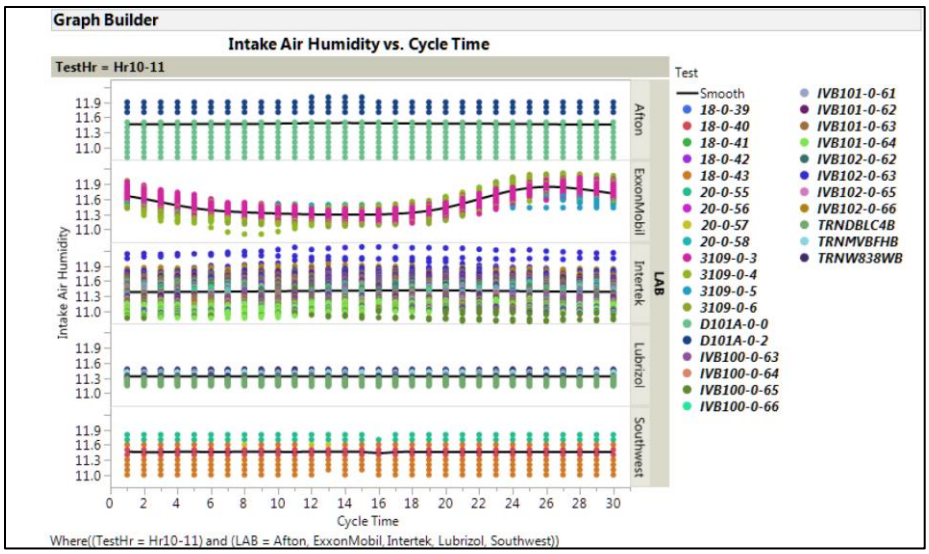
5.19.1. Afton encountered a calibration issue with this parameter.

5.20. Fuel Temperature:



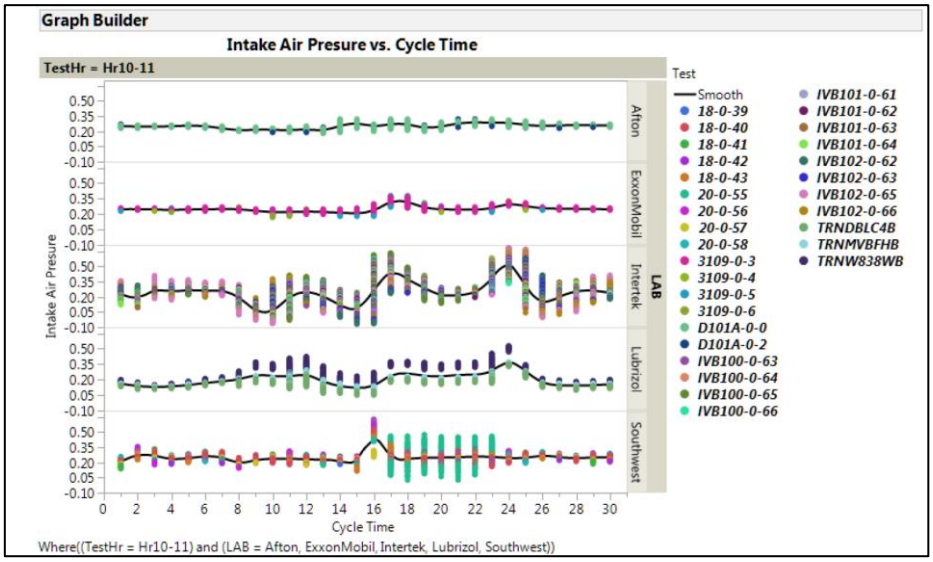
5.20.1. Lubrizol demonstrated the tightest control with fuel temperature.

5.21. Intake Air Humidity:



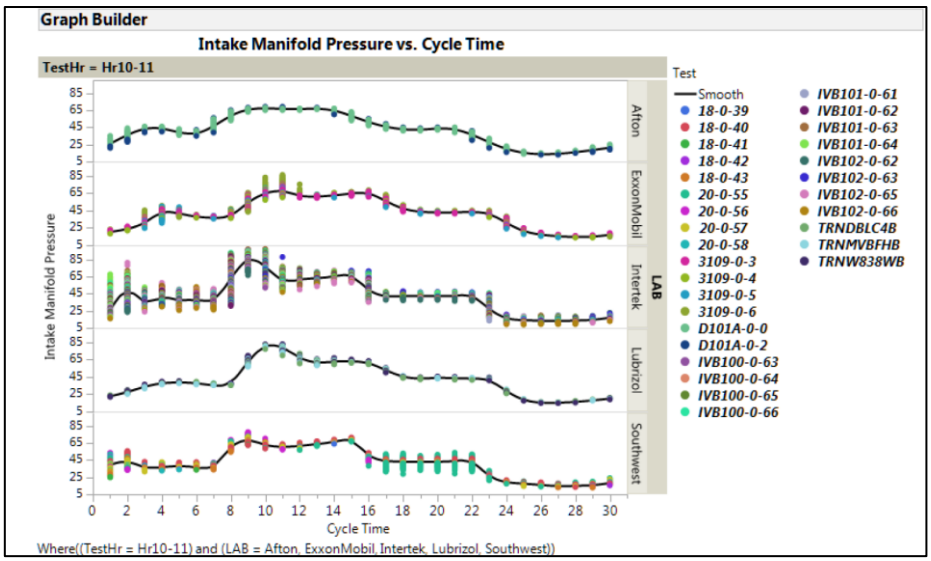
5.21.1. The humidity parameter at Exxon changes over the course of the test cycle.

5.22. Intake Air Pressure:



5.22.1. Intertek appears to be controlling this parameter differently than at the other labs.

5.23. Intake Manifold Pressure:



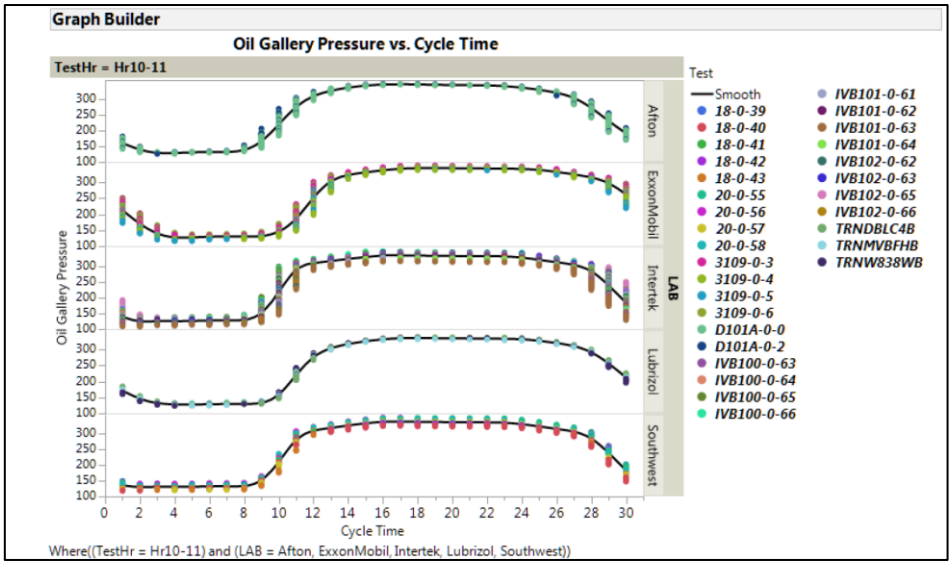
5.23.1. The intake manifold pressure curves correlate to the absolute throttle position curves.

5.23.2. ***Comments from Lubrizol:***

5.23.2.1. All the previous operational data reviews have identified significant differences in intake manifold pressure between the labs.

5.23.2.2. These differences have never been explained.

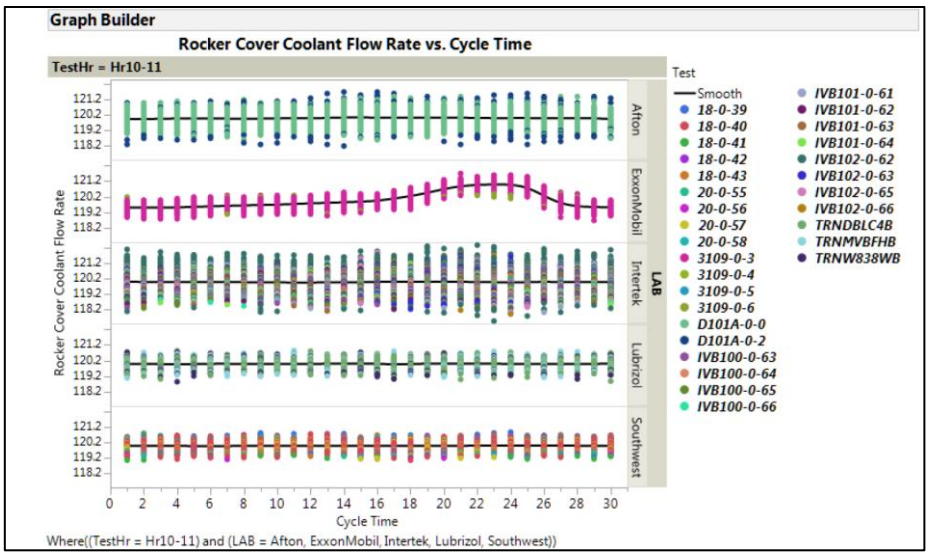
5.24. Oil Pressure:



5.24.1. The oil pressure curves from each lab are similarly shaped.

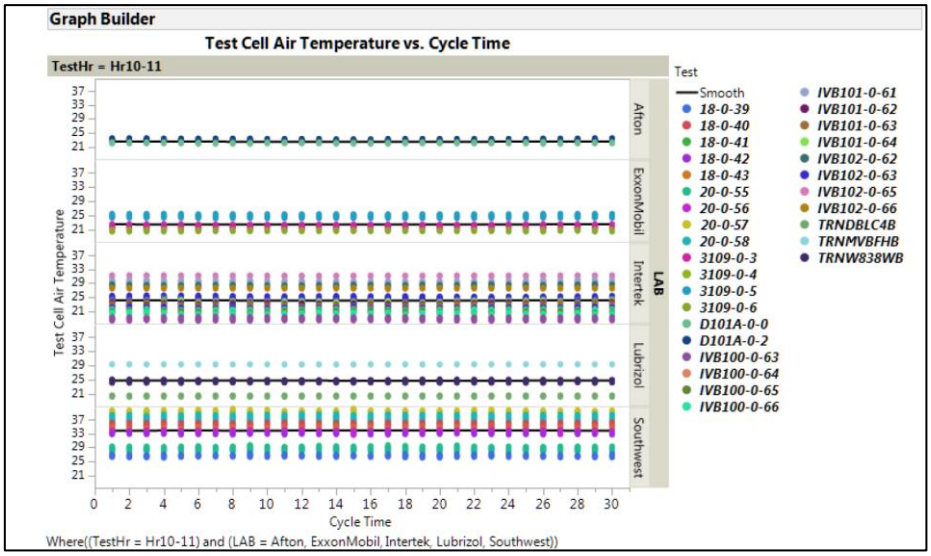
5.24.2. However, there are subtle shifts in time between each curve.

5.25. Rocker Arm Cover Coolant Flow:



5.25.1. Exxon has corrected the "bump" in rocker cover coolant flow that occurred between 18-seconds and 28-seconds.

5.26. Ambient Temperature:



5.26.1. SWRI has the highest ambient temperatures.
- 5.26.1.1. Their lab is configured with multiple test stands in a single cell.
- 5.26.1.2. Extra ambient heat is generated when multiple tests run at the same time.

5.26.2. Afton has extremely consistent ambient temperatures.
- 5.26.2.1. Their test cells are environmentally controlled.

5.27. Parameters Requiring Additional Analysis:

5.27.1. ***The Surveillance Panel agreed to focus on the following parameters (and their impact on test severity) in the future***:
- 5.27.1.1. Oil gallery temperature
- 5.27.1.2. Oil sump temperature
- 5.27.1.3. Intake manifold pressure
- 5.27.1.4. Ambient temperature

Action Items	Person responsible	Completion Date

Follow-up Notes/Updates	Initials	Date Added

Attendees	Organization	Contact Information

ExxonMobil

February 27th, 2018

ExxonMobil Sequence IVB High Wear Oil

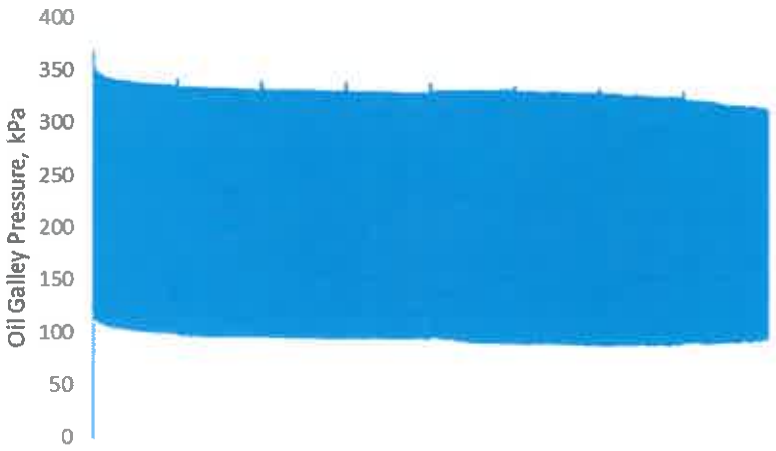
Clifford Salvesen
Paulsboro Technology Center

ProveOut/Precision Matrix Data

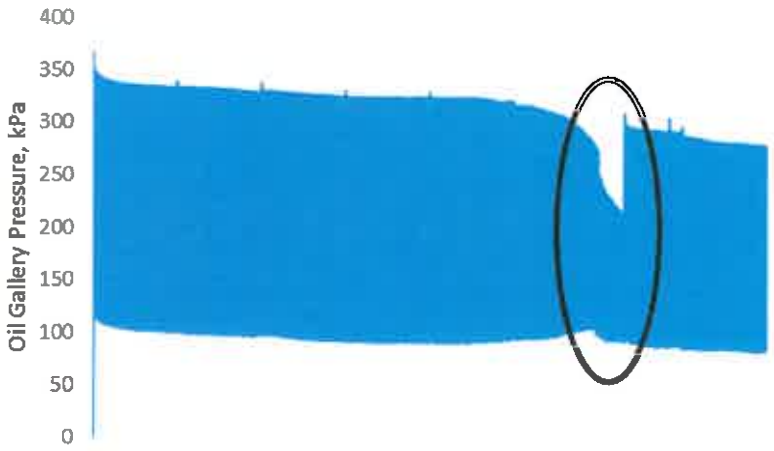
	Oil	Intake Wear mm^3	Exhaust Wear mm^3	Intake Mass Loss g	Exhaust Mass Loss g	EOT Iron ppm
ProveOut 1	300	1.53	N/A			176
ProveOut 2	1012	1.31	N/A			108
PrecisionMatrix 1	1012	1.81	N/A	20.1	8.6	212
PrecisionMatrix 2	1011	1.84	.93	15.7	9.6	154
PrecisionMatrix 3	1011	2.03	1.10	20.4	11.3	186
PrecisionMatrix 4	300	1.81	0.85	18.1	8.8	173
HighWearOil 1	HW1	2.83	5.82	24.81	49.25	699
HighWearOil 2	HW1	1.89	2.84	15.95	28.98	Pending

Differences between High Wear Oil Runs – Oil Pressure

High Wear Oil Test 1



High Wear Oil Test 2



Timing chain rattle and low oil pressure observed at 171 hours, oil topped up (800 mL) and pressure returned to normal

Full oil consumption numbers pending

ExxonMobil

Differences between High Wear Oil Runs – Oil Pressure

From procedure:

11.4.1 Optional *oil level procedure*— After 200 h of test operation and the final oil sample, allow the engine to run at stage 1 conditions for 10 min before shutting down. Let the engine rest turned off for 10 min and then measure the end-of-test oil level using the OHT IVB dipstick (see Fig. 10) inserted into the side of the oil pan.

Figure 10

High Wear Oil Test 1

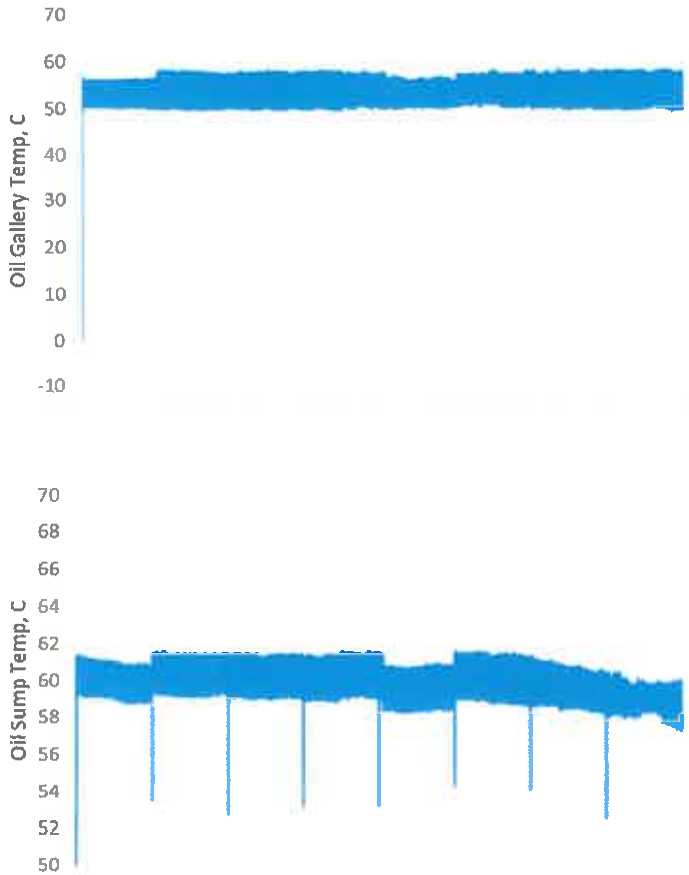
EOT Dipstick Level: 55

High Wear Oil Test 2

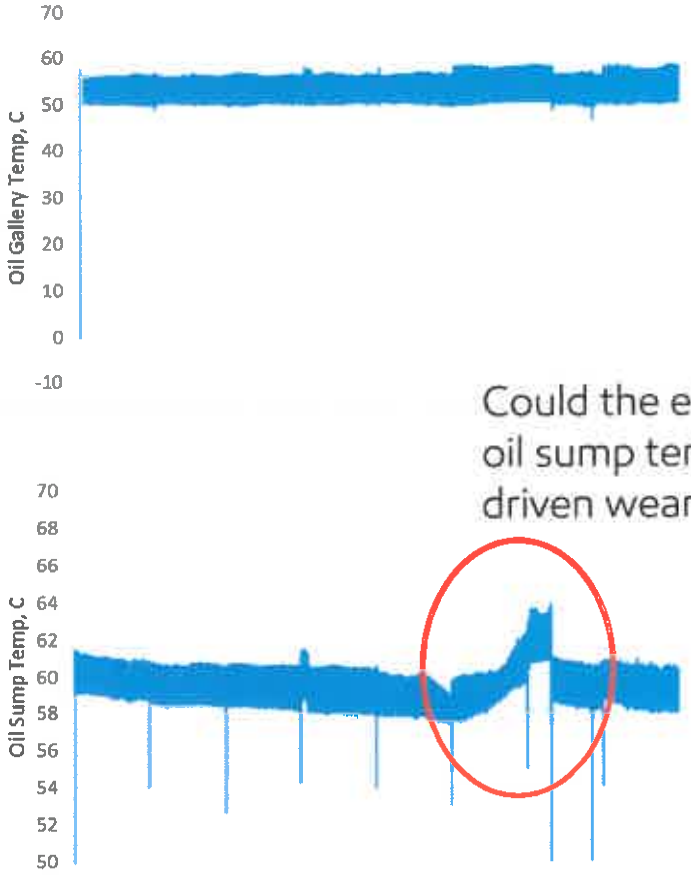
Hour 171 Dipstick Level:	42
Hour 171 Post 800mL Addition:	70
EOT Dipstick Level:	44

Differences between High Wear Oil Runs – Oil Temps

High Wear Oil Test 1



High Wear Oil Test 2

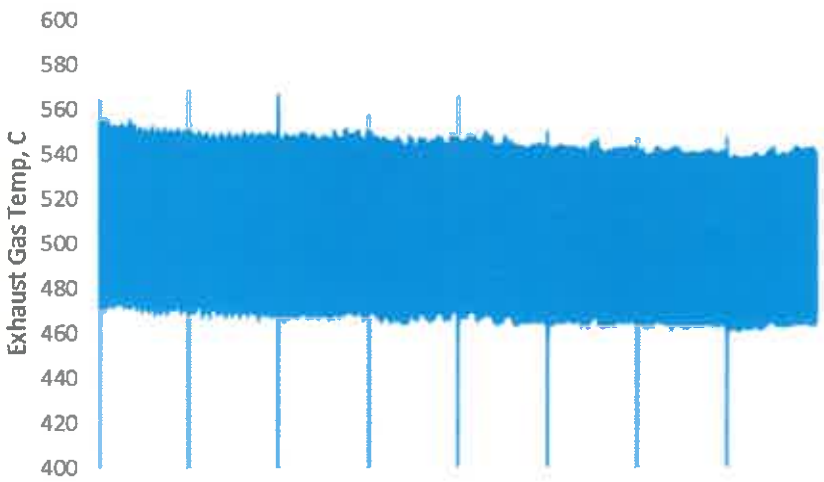


Could the elevated oil sump temps have driven wear mild?

ExxonMobil

Differences between High Wear Oil Runs – Exhaust Temp

High Wear Oil Test 1



High Wear Oil Test 2

No large exhaust temp differences observed

ExxonMobil

Differences between High Wear Oil Runs - QIs

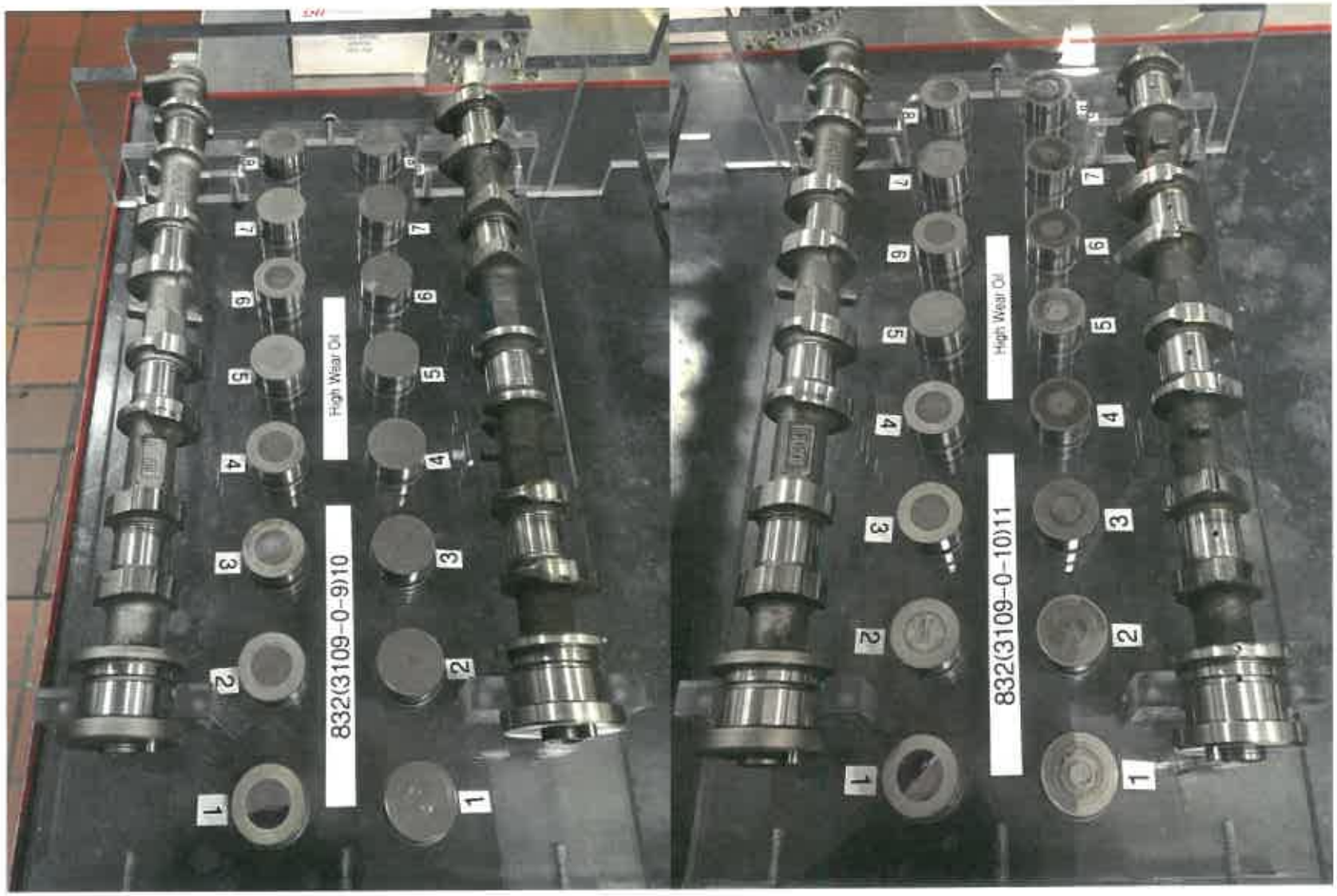
High Wear Oil Test 1

Parameter	Units	QI Threshold	EOT QI
Speed	r/min	0.000	Pending
Torque	n·m	0.000	0.745
Engine Oil Gallery	°C	0.000	0.802
Engine Coolant Out	°C	0.000	0.793
Engine Coolant Flow	L/min	0.000	0.939
Engine Coolant Pressure	kPa	0.000	0.7870
RAC Coolant Out	°C	0.000	1.0
Load Cell	°C	0.000	0.9600
RAC Flow	L/min	0.000	0.7
Intake Air	°C	0.000	0.895
Intake Air Pressure	kPa	0.000	0.986
Intake Air Humidity	g/kg	0.000	0.922
Fuel Rail Temperature	°C	0.000	0.698
Blowby Gas	°C	0.000	0.869
Fuel Rail Pressure	kPa	0.000	0.910
Exhaust Backpressure	kPaA	0.000	-0.605

High Wear Oil Test 2

Parameter	Units	QI Threshold	EOT QI
Speed	r/min	0.000	Pending
Torque	n·m	0.000	0.740
Engine Oil Gallery	°C	0.000	0.823
Engine Coolant Out	°C	0.000	0.805
Engine Coolant Flow	L/min	0.000	0.925
Engine Coolant Pressure	kPa	0.000	0.865
RAC Coolant Out	°C	0.000	.992
Load Cell	°C	0.000	0.9600
RAC Flow	L/min	0.000	0.701
Intake Air	°C	0.000	0.971
Intake Air Pressure	kPa	0.000	0.987
Intake Air Humidity	g/kg	0.000	0.932
Fuel Rail Temperature	°C	0.000	0.919
Blowby Gas	°C	0.000	0.951
Fuel Rail Pressure	kPa	0.000	0.885
Exhaust Backpressure	kPaA	0.000	-0.665

Photos from EOT - Valvetrain



ExxonMobil

Sequence IV Surveillance Panel

Conference Call
March 1, 2018
2:00 p.m. - 4:00 p.m.

AGENDA

1. Chairman comments
2. Membership changes
3. Review of additional Sequence IVB prove-out test results
4. Sequence IVB Precision Matrix 2 statistical analysis review: Correlation analysis and conclusions
5. Sequence IVB 1-hour operational data analysis review 10–11, 101–102 and 195–196 hours
6. Motion and action item review
7. Next meeting
8. Adjourn

MEMBERSHIP
SEQUENCE IV SURVEILLANCE PANEL

March 1, 2018

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SEQUENCE IV SURVEILLANCE PANEL

March 1, 2018

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MEMBERSHIP
SEQUENCE IV SURVEILLANCE PANEL

March 1, 2018

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SEQUENCE IV SURVEILLANCE PANEL

March 1, 2018

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Brys, Jerome	Lubrizol Corporation 29400 Lakeland Blvd. Wickliffe, OH 44092 Phone No.: 440-347-2631 / 440-943-1200 Fax No.: 440-943-9013 Email: jabs@lubrizol.com	

NON-MEMBER MAILING LIST
SEQUENCE IV SURVEILLANCE PANEL

March 1, 2018

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NON-MEMBER MAILING LIST
SEQUENCE IV SURVEILLANCE PANEL

March 1, 2018

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NON-MEMBER MAILING LIST
SEQUENCE IV SURVEILLANCE PANEL

March 1, 2018

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NON-MEMBER MAILING LIST
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March 1, 2018

NAME	COMPANY-ADDRESS-PHONE-FAX-EMAIL	SIGNATURE
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Tumati, Prasad	Haltermann Phone No.: Fax No.: Email: ptumati@jhaltermann.com	
	Phone No.: Fax No.: Email:	

NON-MEMBER MAILING LIST
SEQUENCE IV SURVEILLANCE PANEL

March 1, 2018

NAME	COMPANY-ADDRESS-PHONE-FAX-EMAIL	SIGNATURE
	Phone No.: Fax No.: Email:	
	Phone No.: Fax No.: Email:	
	Phone No.: Fax No.: Email:	
	Phone No.: Fax No.: Email:	
	Phone No.: Fax No.: Email:	
	Phone No.: Fax No.: Email:	
	Phone No.: Fax No.: Email:	
	Phone No.: Fax No.: Email:	

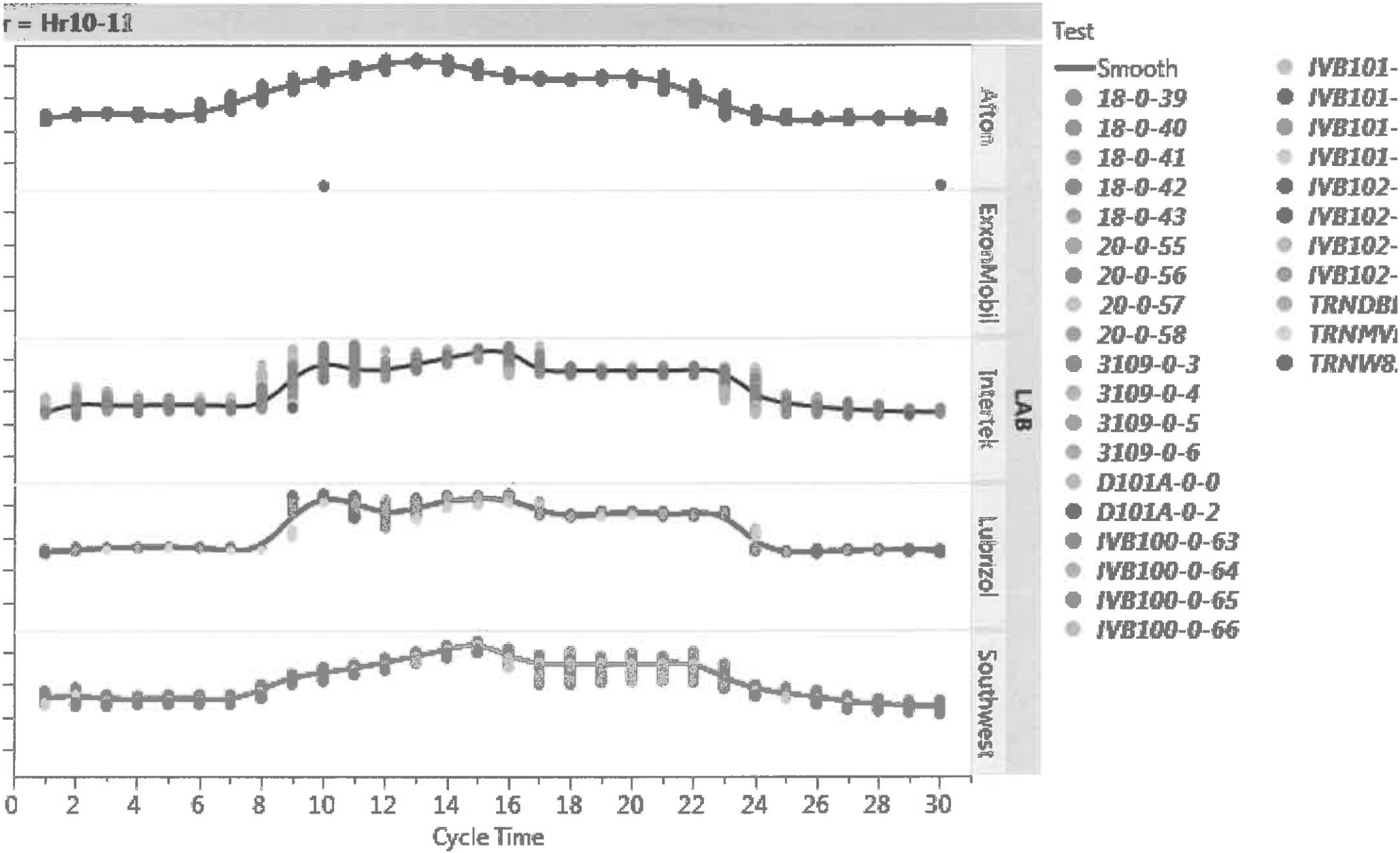
Operational Plots for All Labs Hrs 10-11, Exclusively

By: Stats Group

02-28-18

h Builder

Abs. Throttle Position vs. Cycle Time

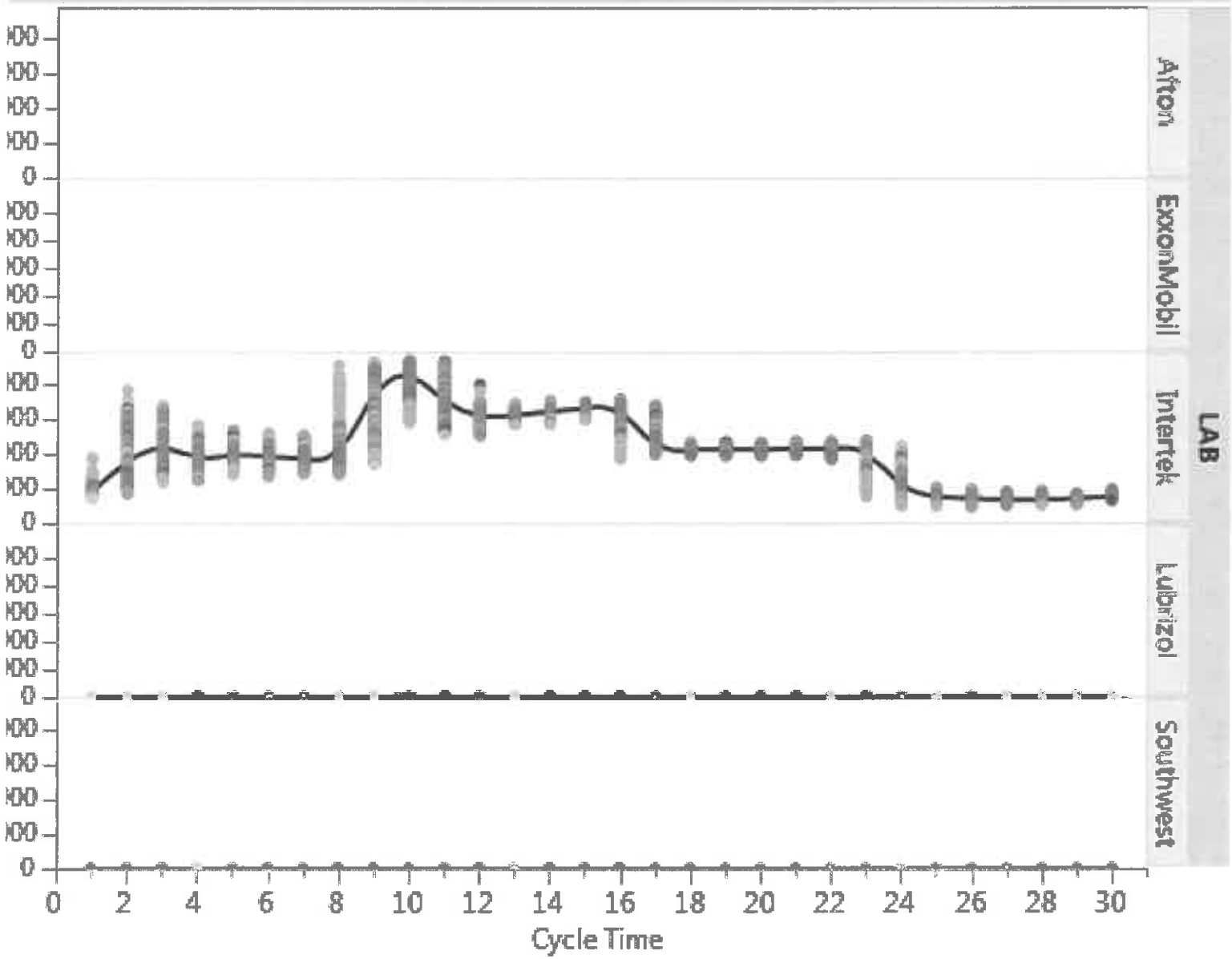


(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Absolute Load vs. Cycle Time

r = Hr10-11



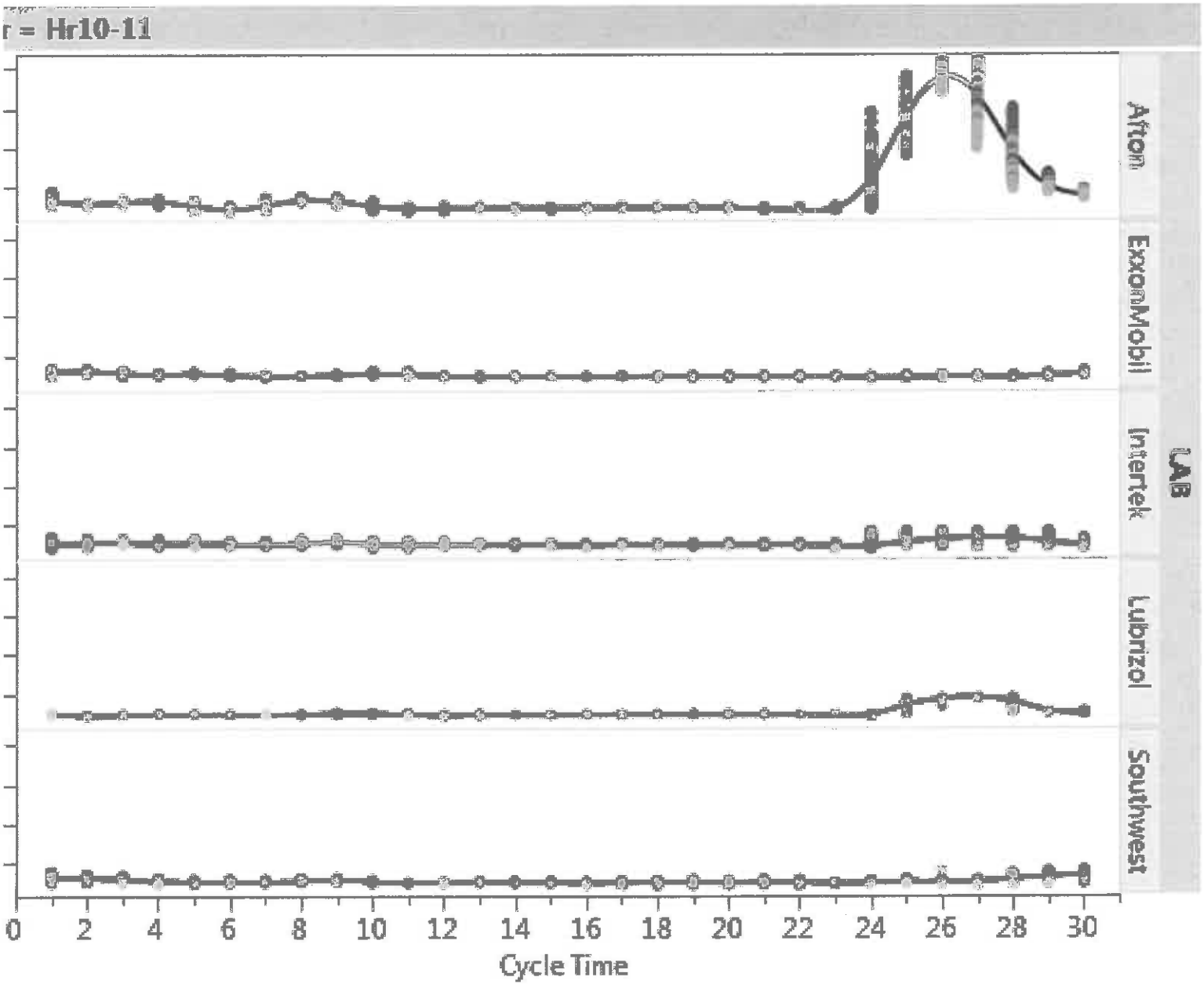
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Air Fuel Ratio vs. Cycle Time

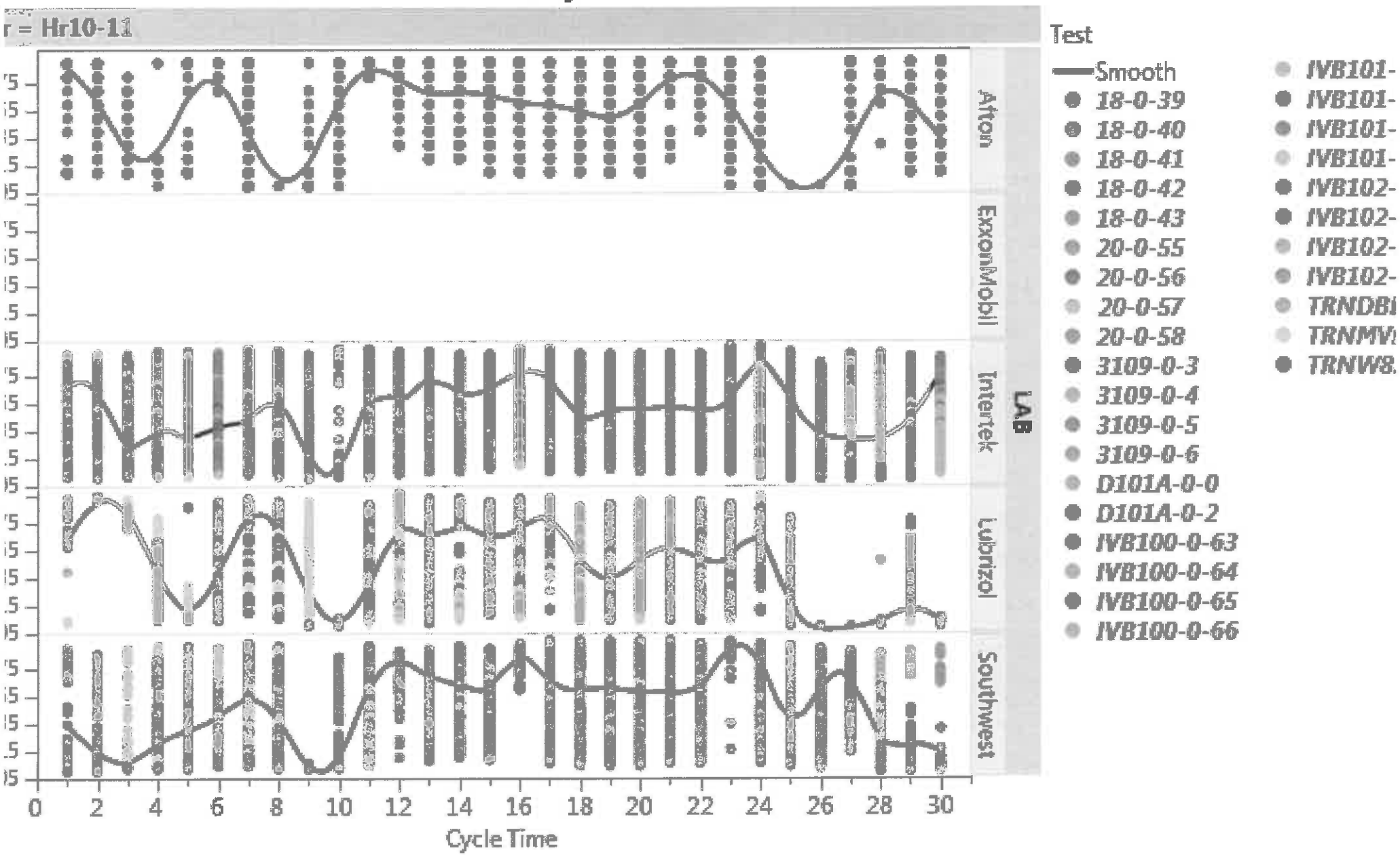


Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

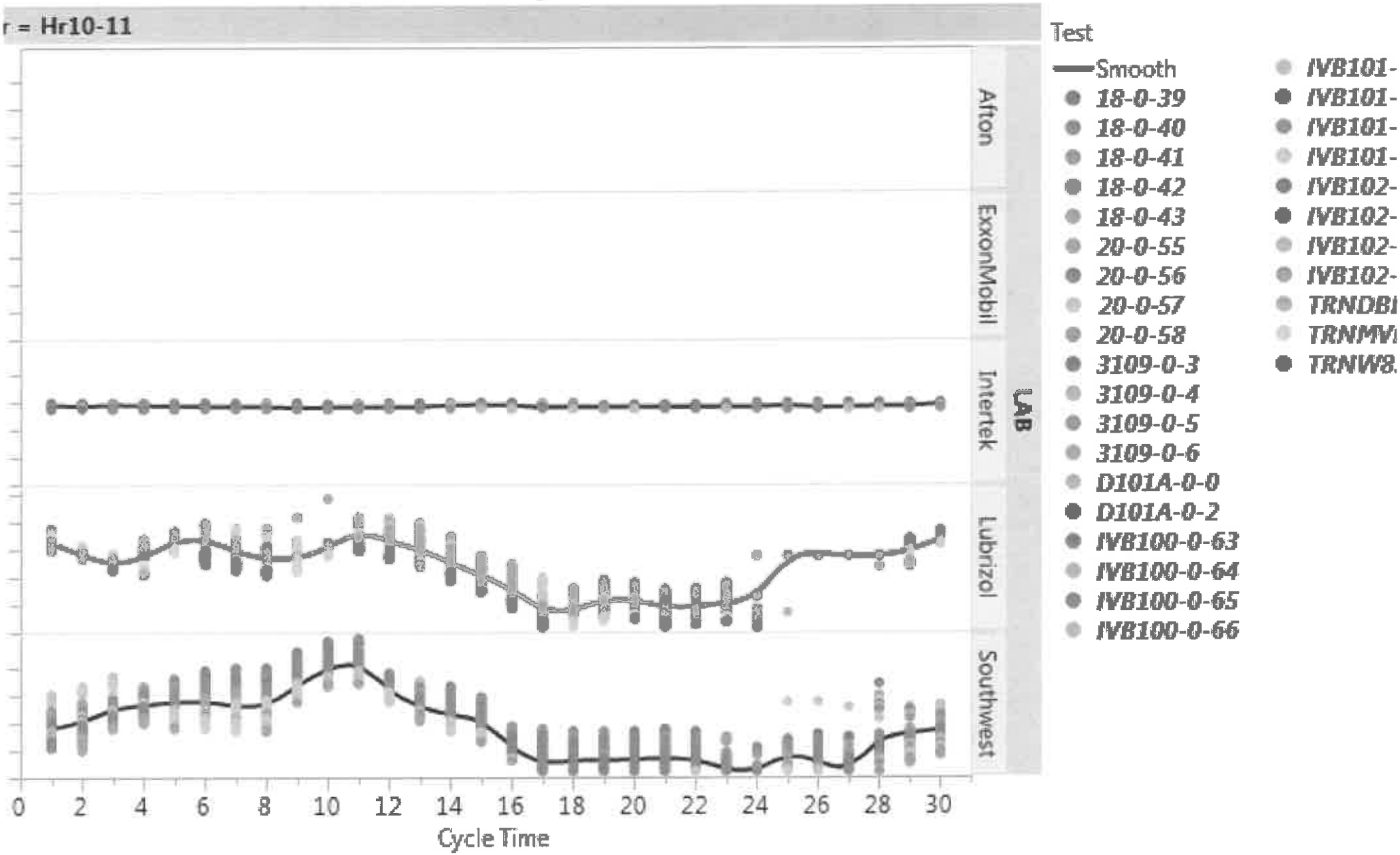
h Builder



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Bank 1 STFT vs. Cycle Time

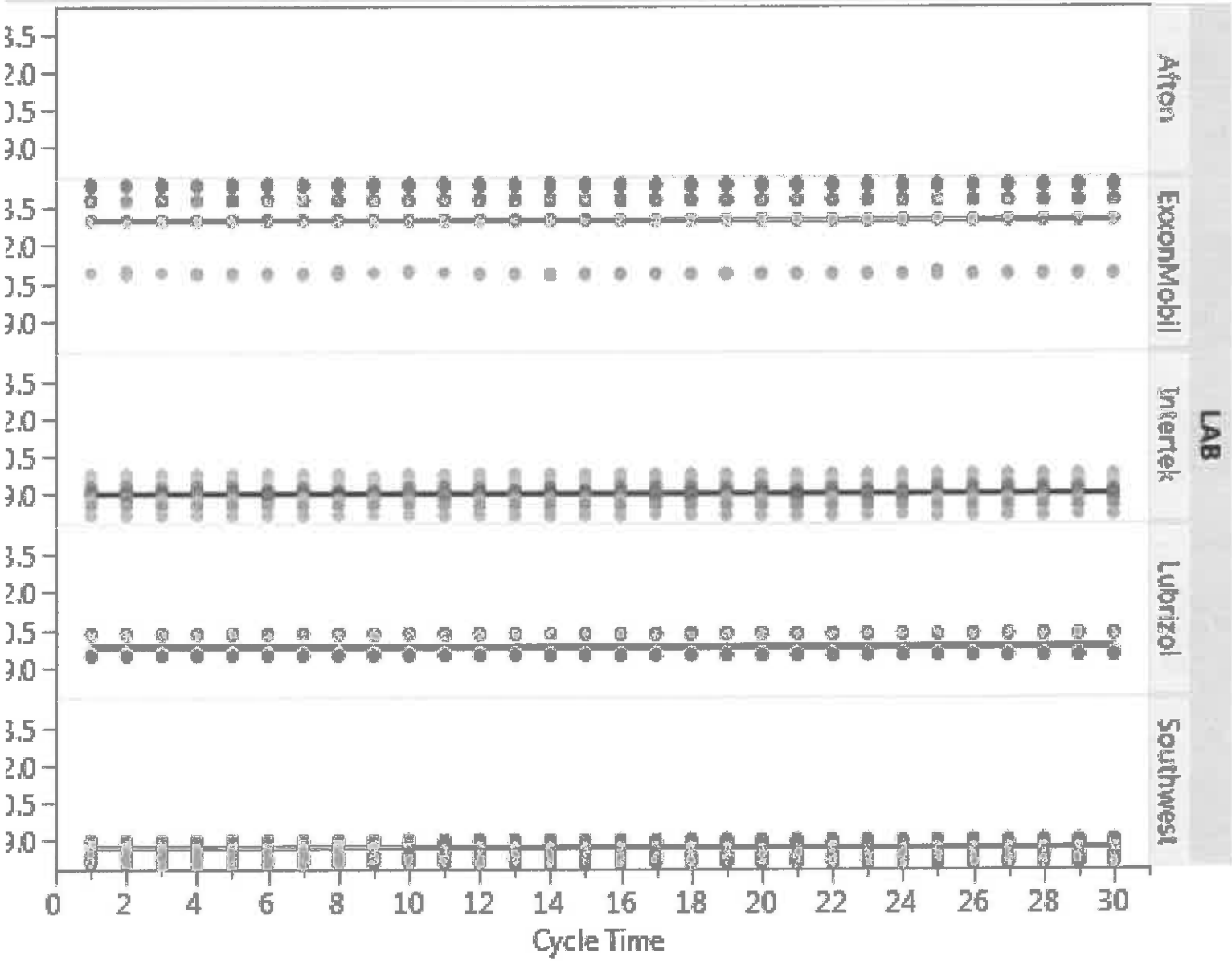


(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Barometric Pressure vs. Cycle Time

r = Hr10-11



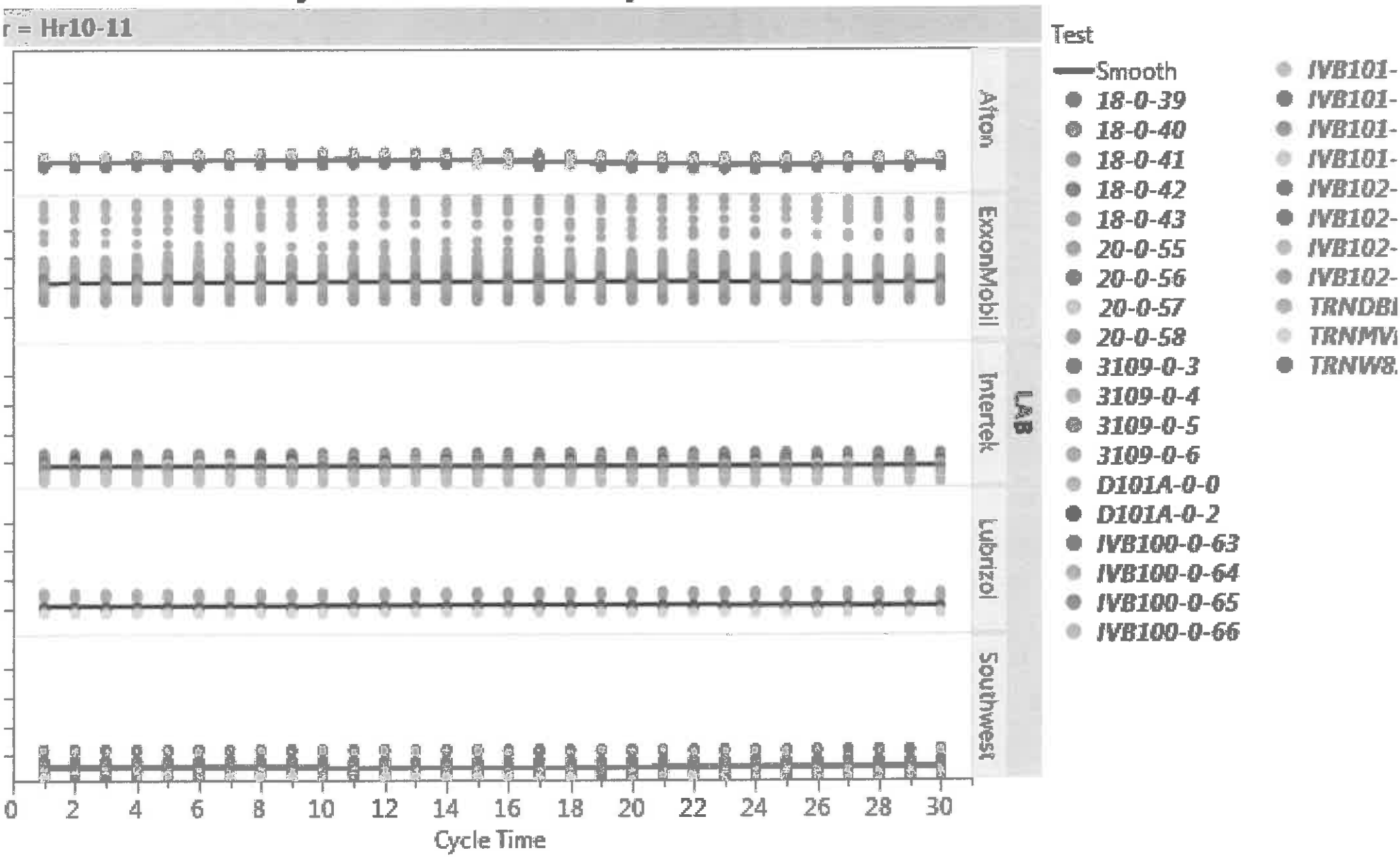
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

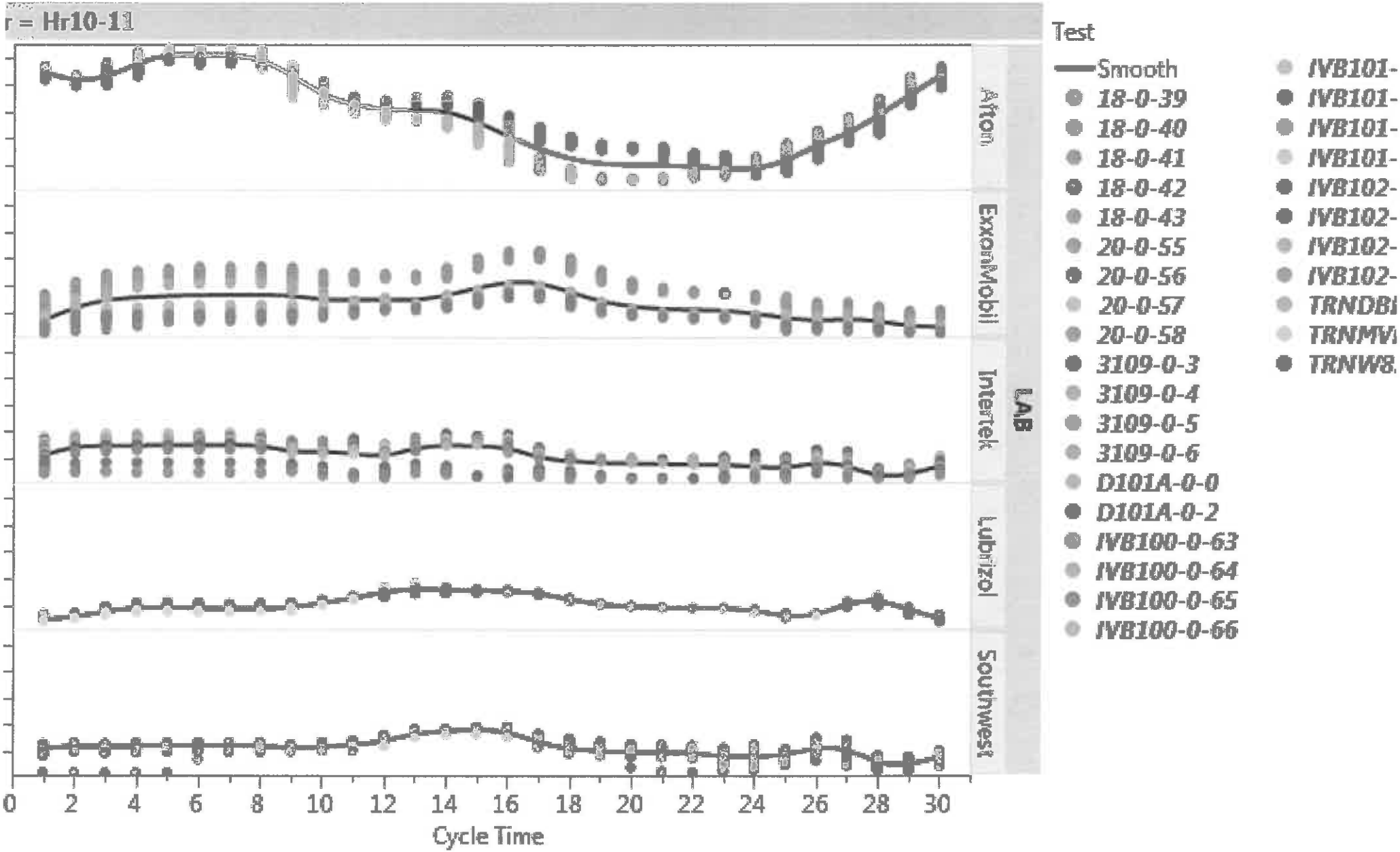
Blowby Coolant at Outlet vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

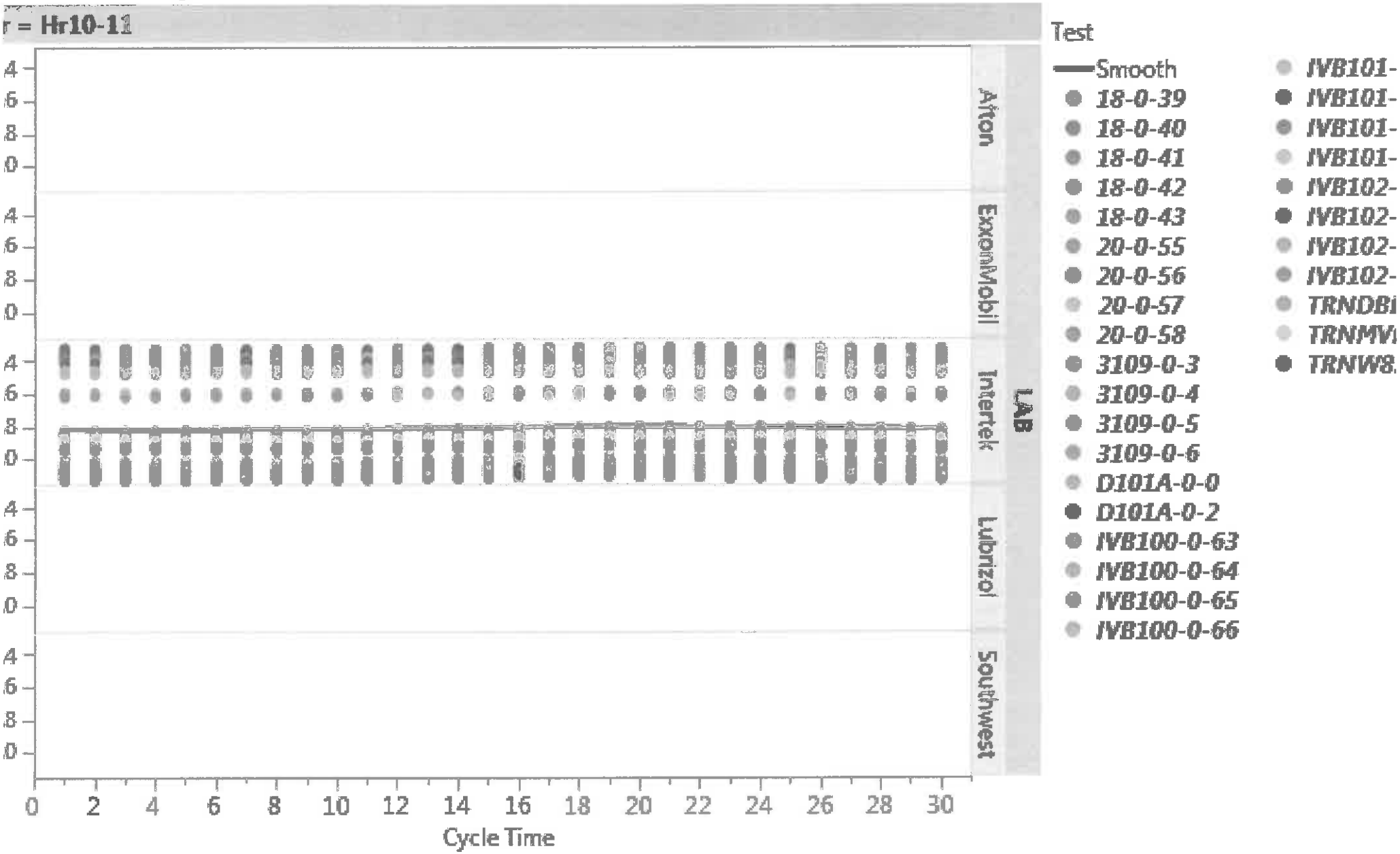
Blowby Flow Rate vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

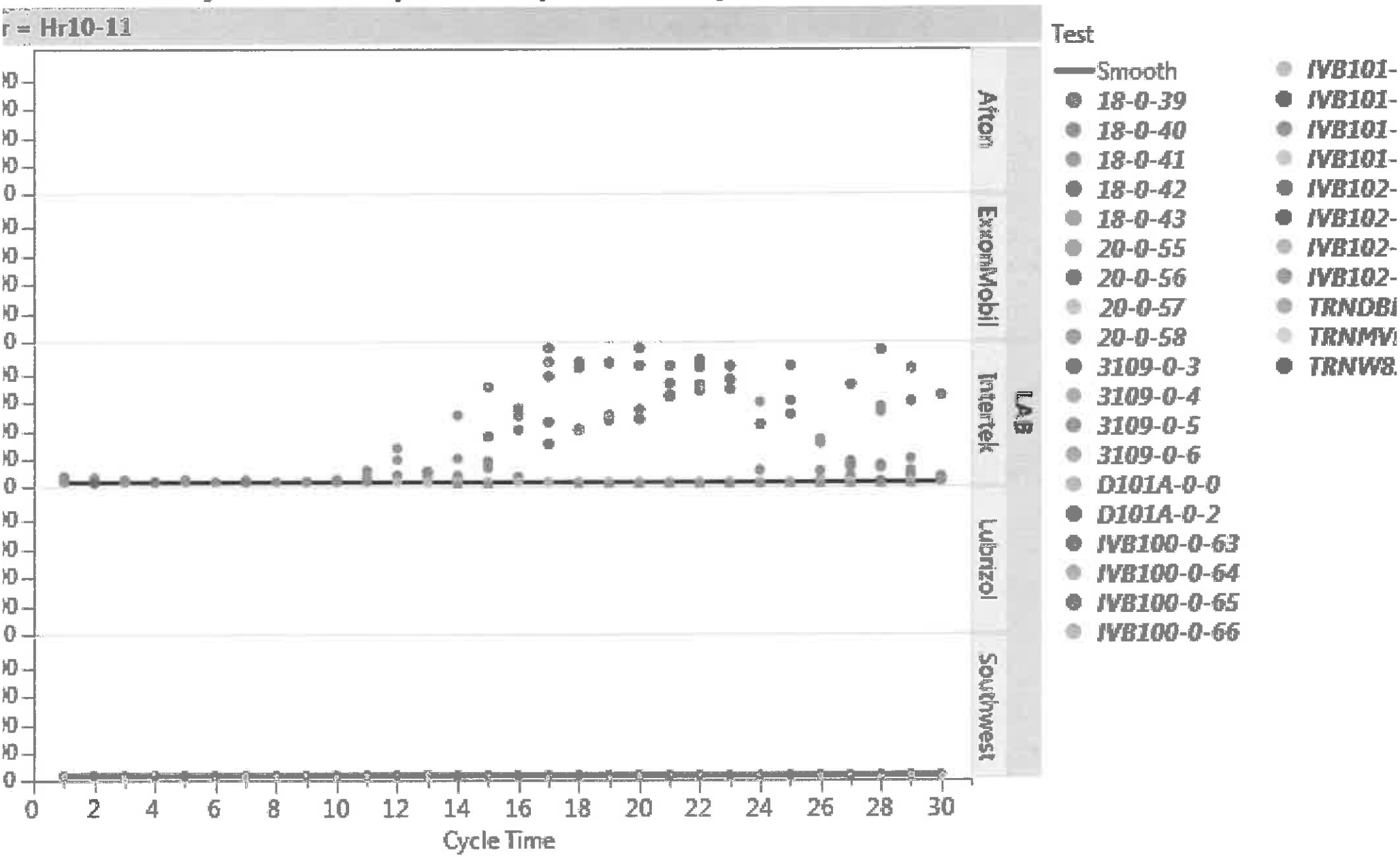
Blowby Gas in Oil Separator (IAR Optional) vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

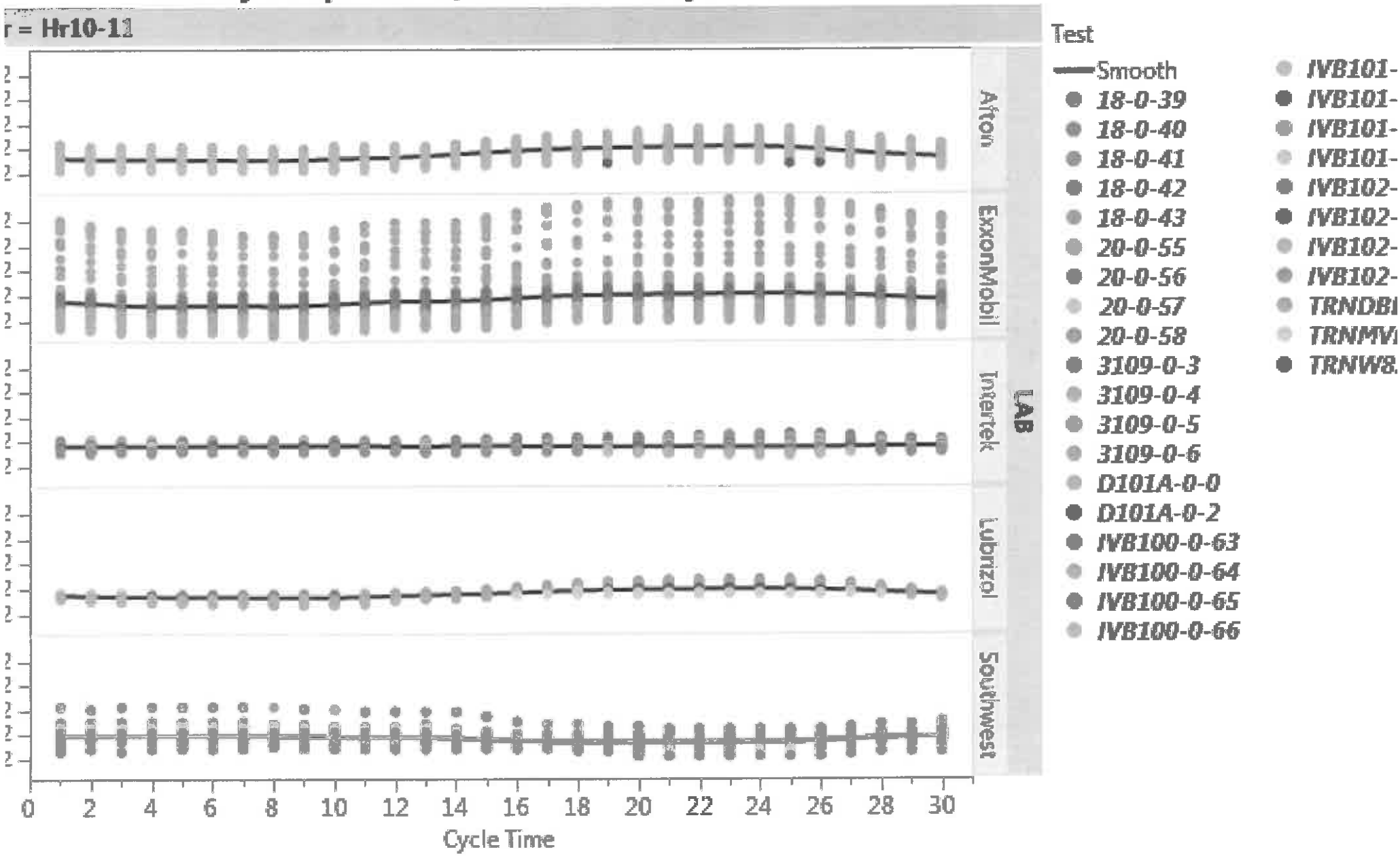
Blowby Gas in Oil Separator (Optional) vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Blowby Temperature (Controlled) vs. Cycle Time

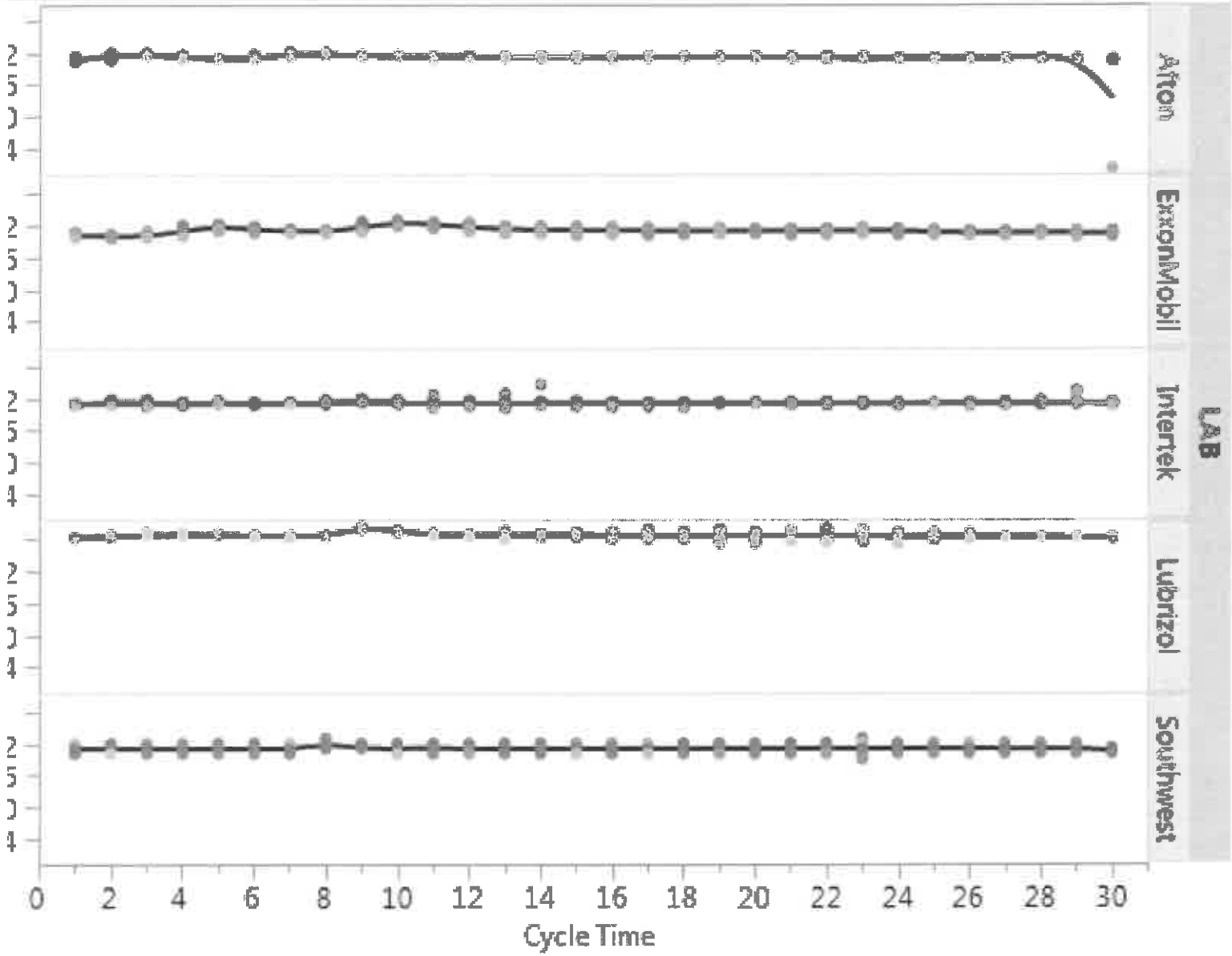


(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Brake Mean Effective Pressure vs. Cycle Time

r = Hr10-11



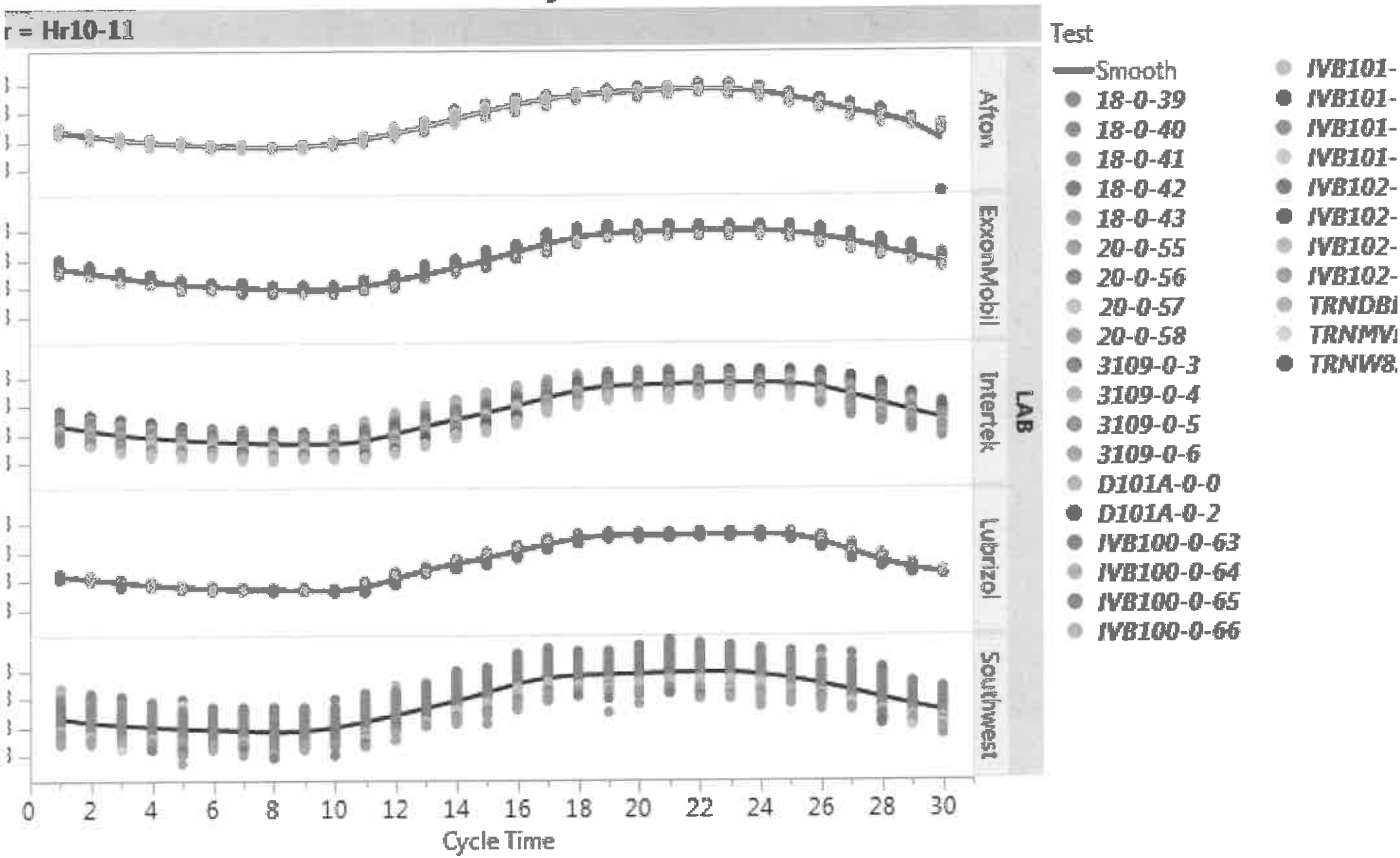
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

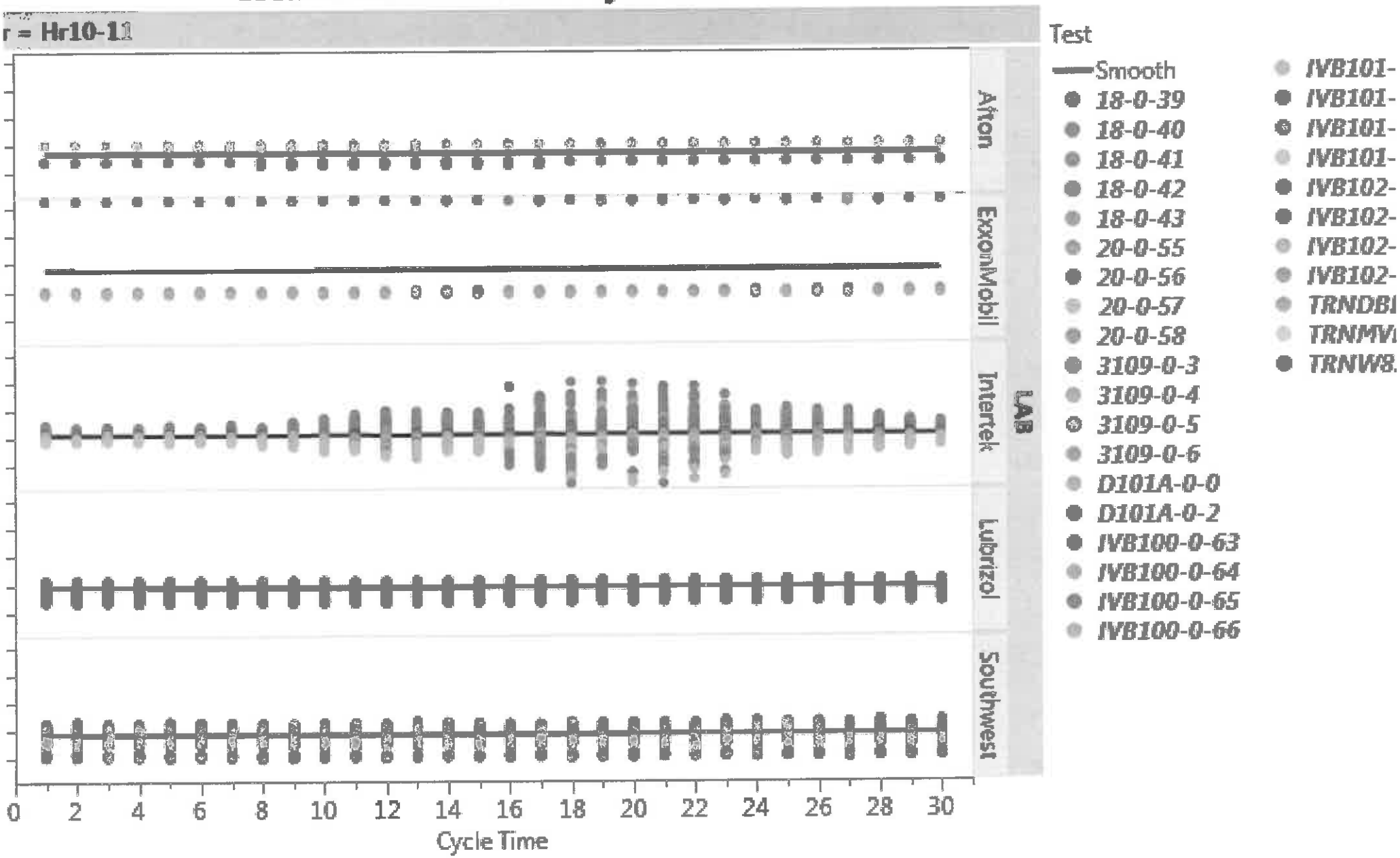
Coolant Delta vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Inlet Pressure vs. Cycle Time

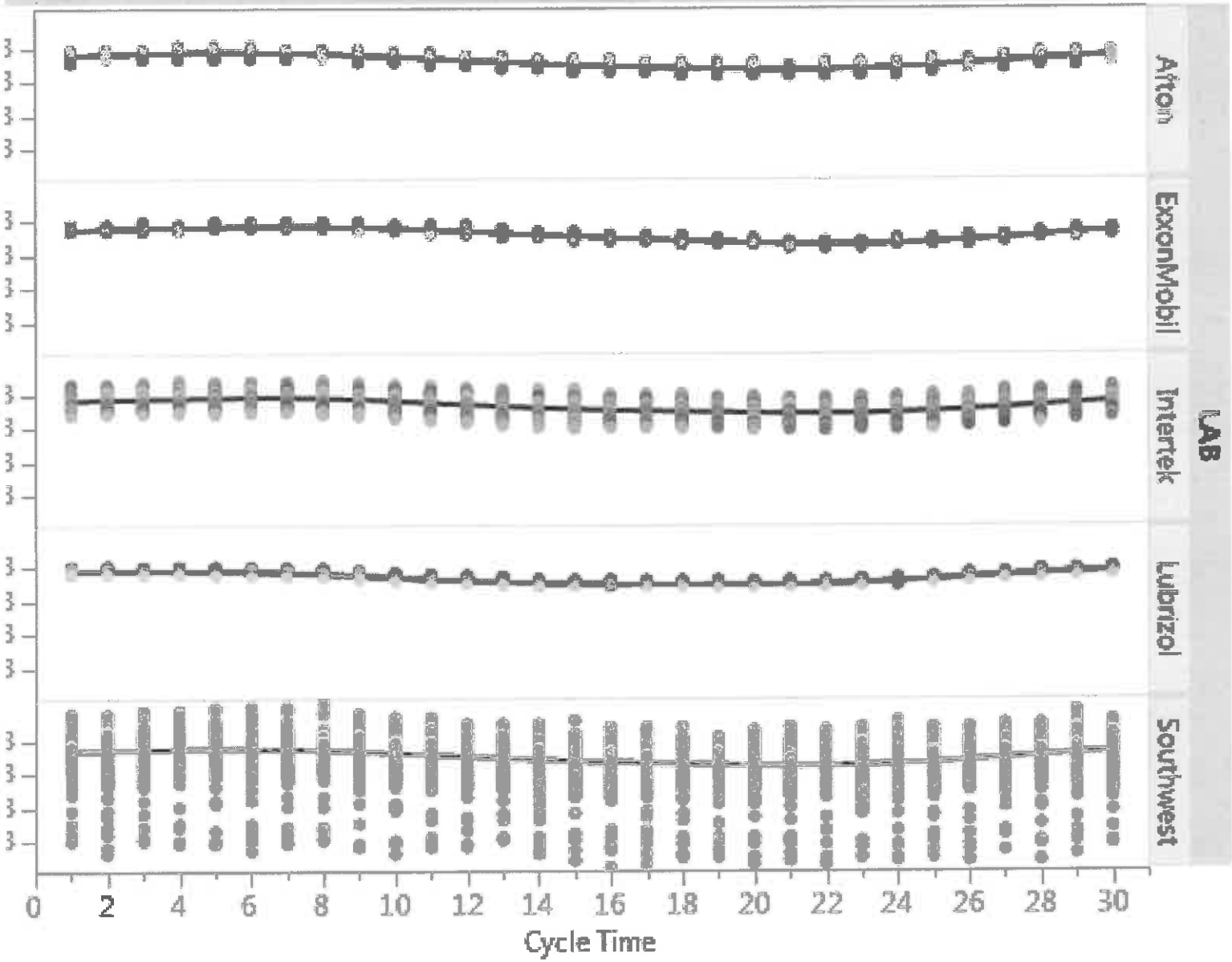


(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Temperature Into Engine vs. Cycle Time

r = Hr10-11



Test

Smooth

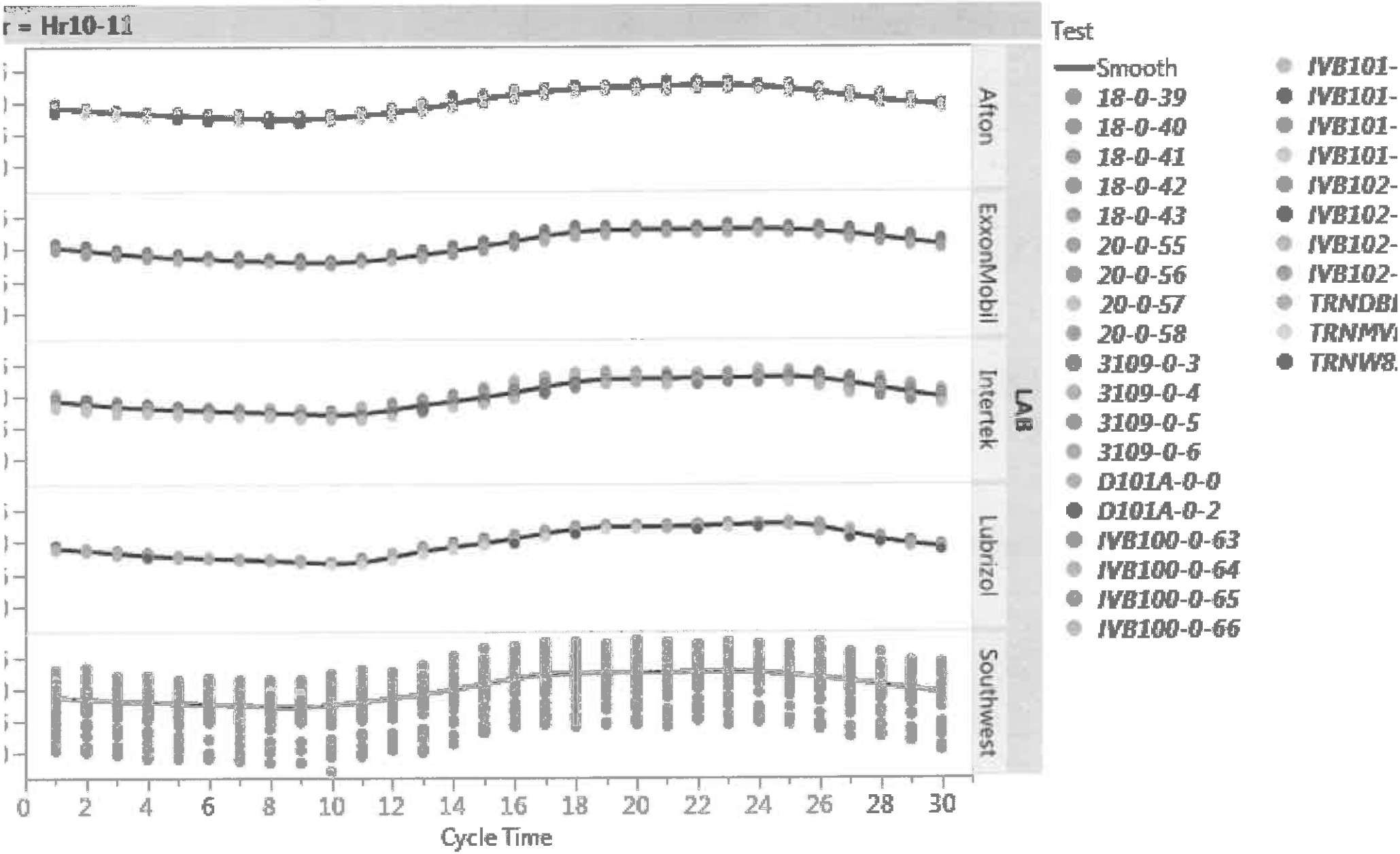
18-0-39
18-0-40
18-0-41
18-0-42
18-0-43
20-0-55
20-0-56
20-0-57
20-0-58
3109-0-3
3109-0-4
3109-0-5
3109-0-6
D101A-0-0
D101A-0-2
IVB100-0-63
IVB100-0-64
IVB100-0-65
IVB100-0-66

IVB101-
IVB101-
IVB101-
IVB101-
IVB102-
IVB102-
IVB102-
IVB102-
TRNDBI
TRNMVI
TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Temperature Out of Engine vs. Cycle Time

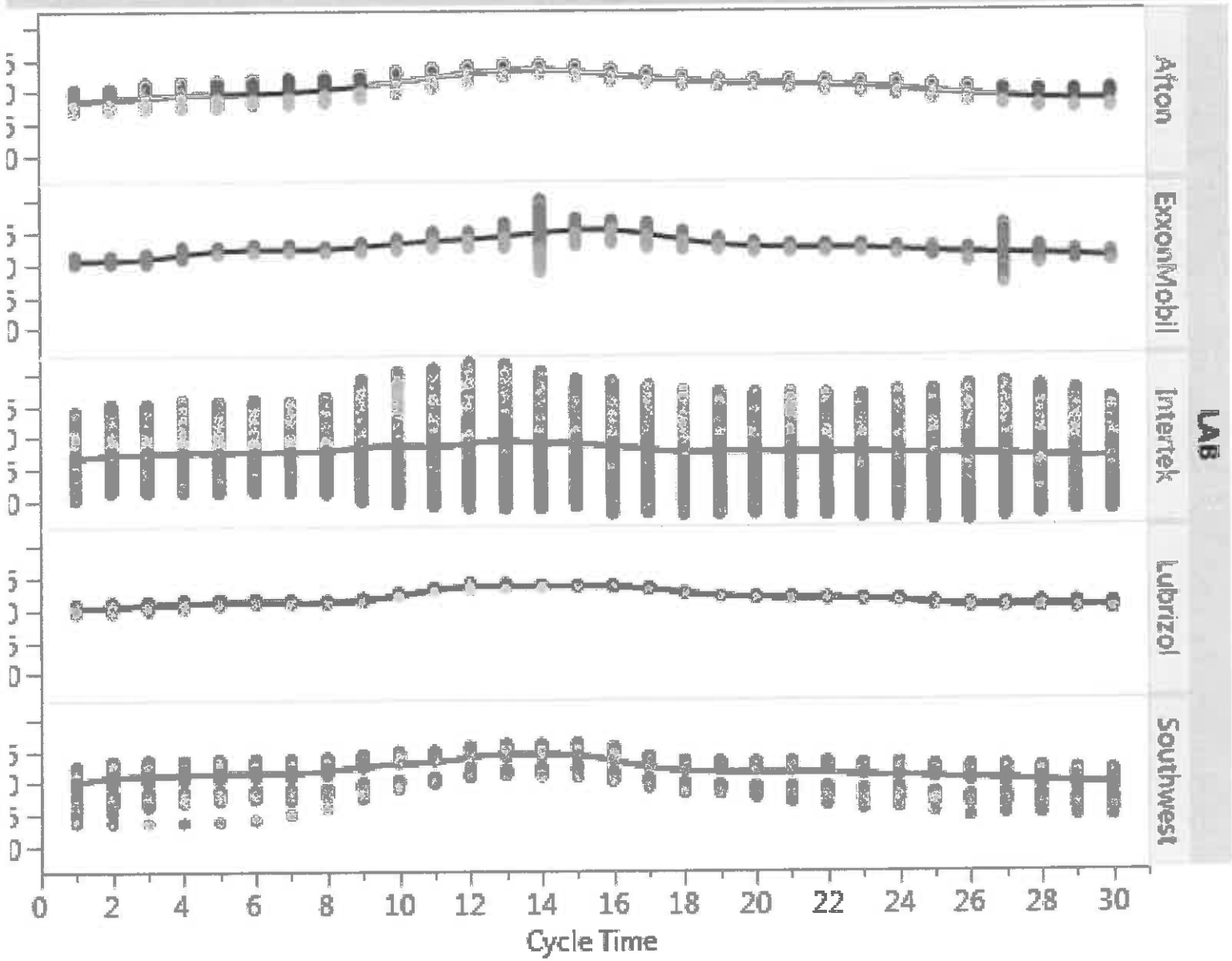


(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Crankcase Gas Pressure vs. Cycle Time

r = Hr10-11



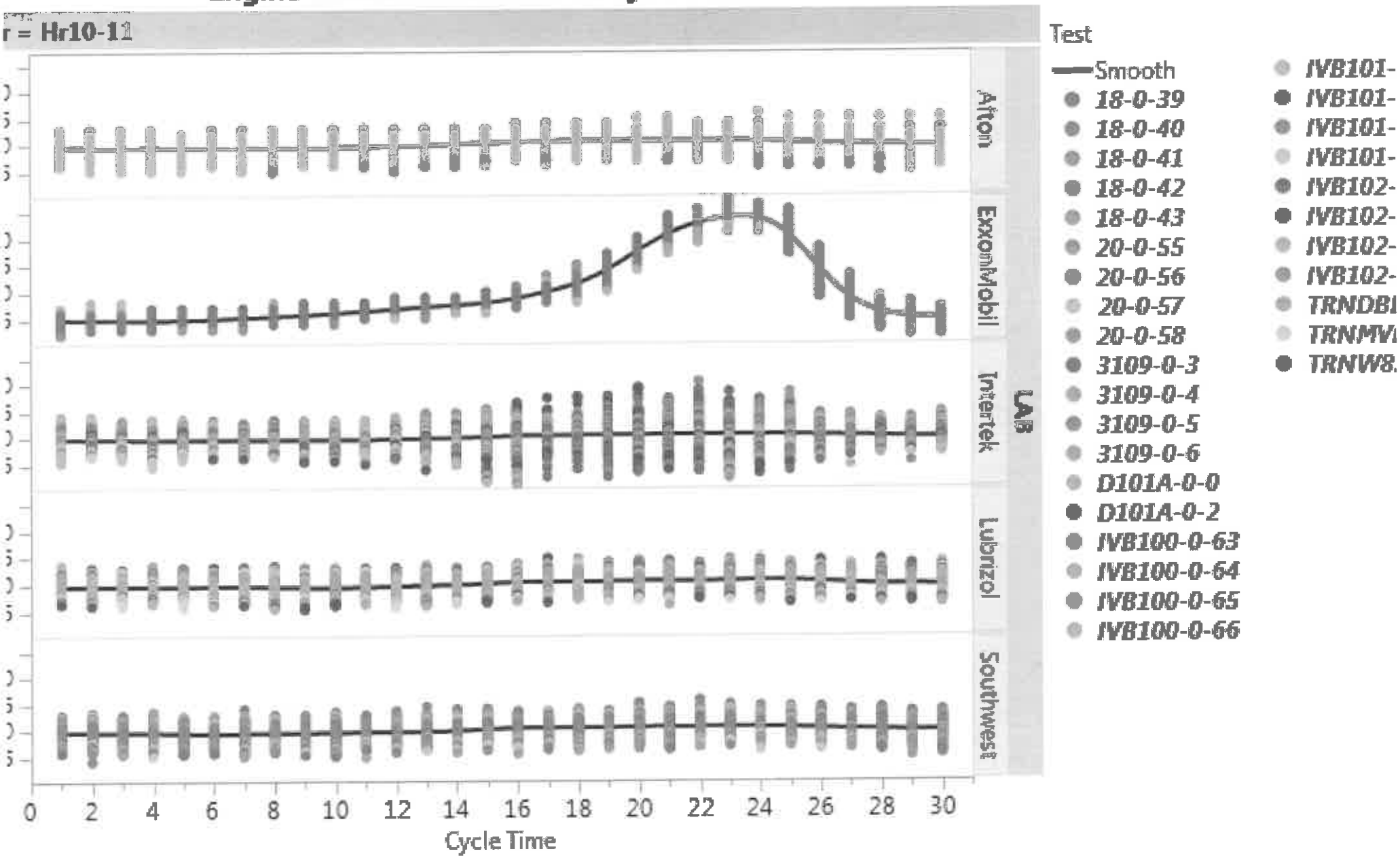
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

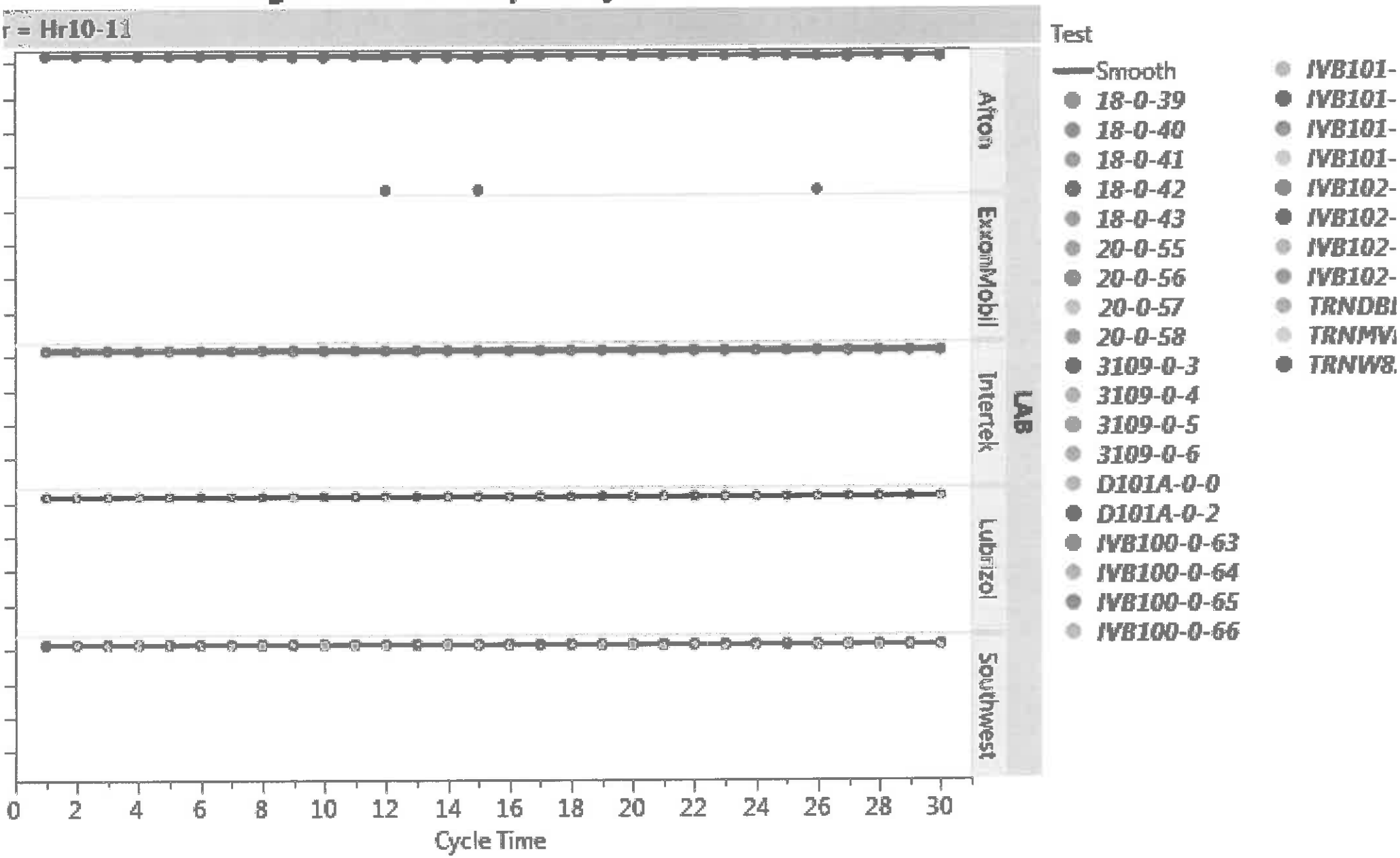
Engine Coolant Flow Rate vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

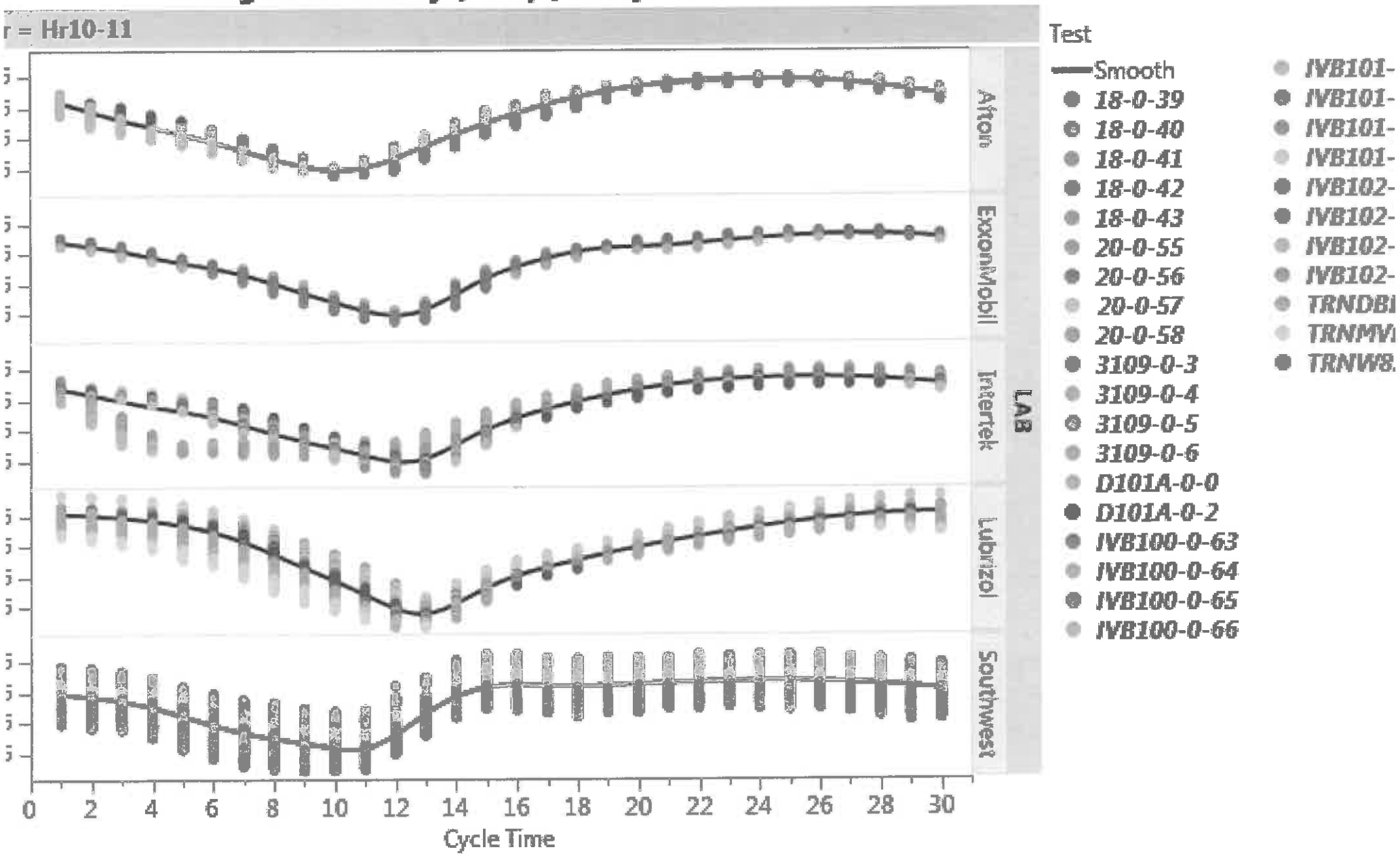
Engine Coolant Temp. vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

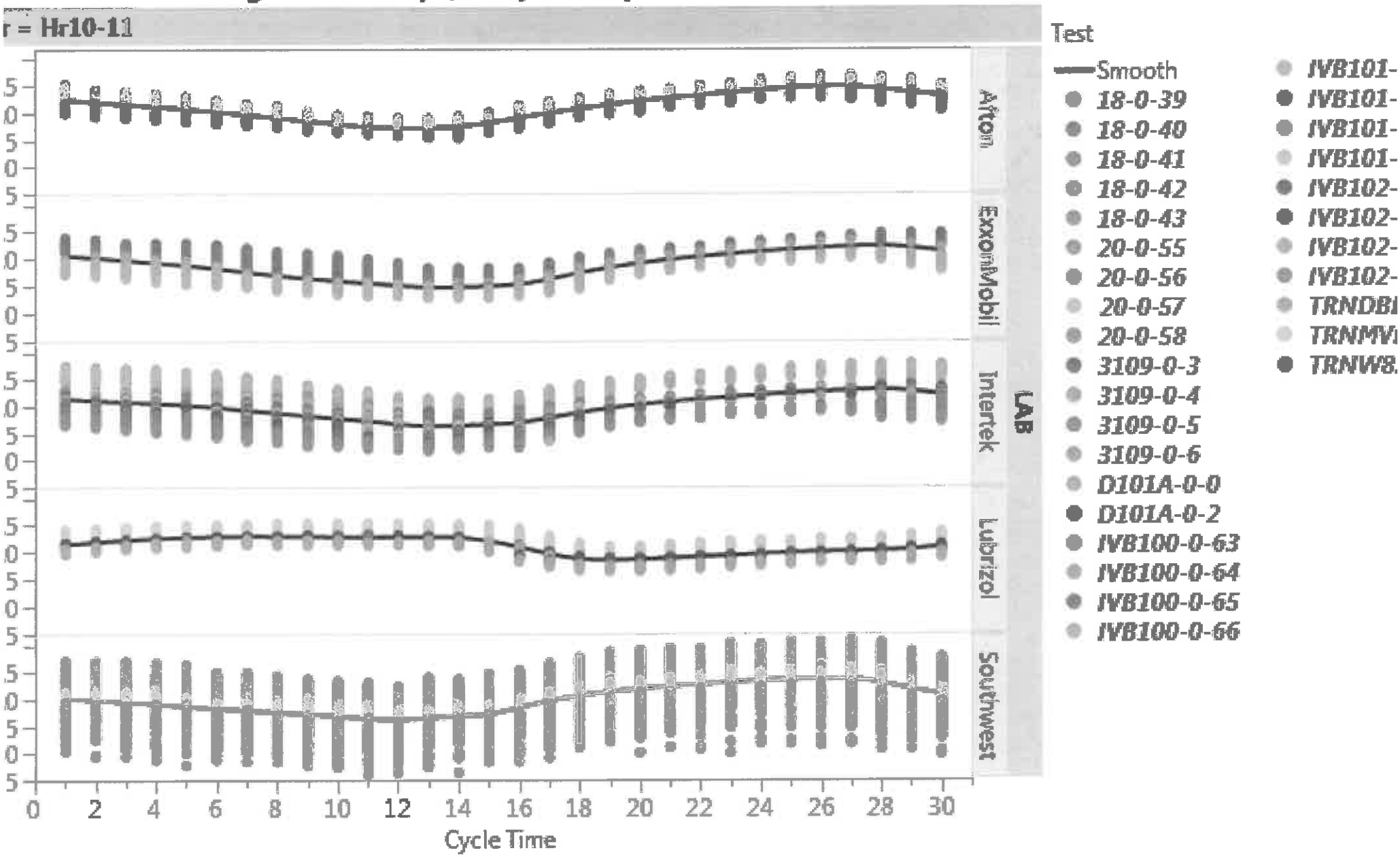
Engine Oil Gallery (Temp.) vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Oil Sump (Temp.) vs. Cycle Time

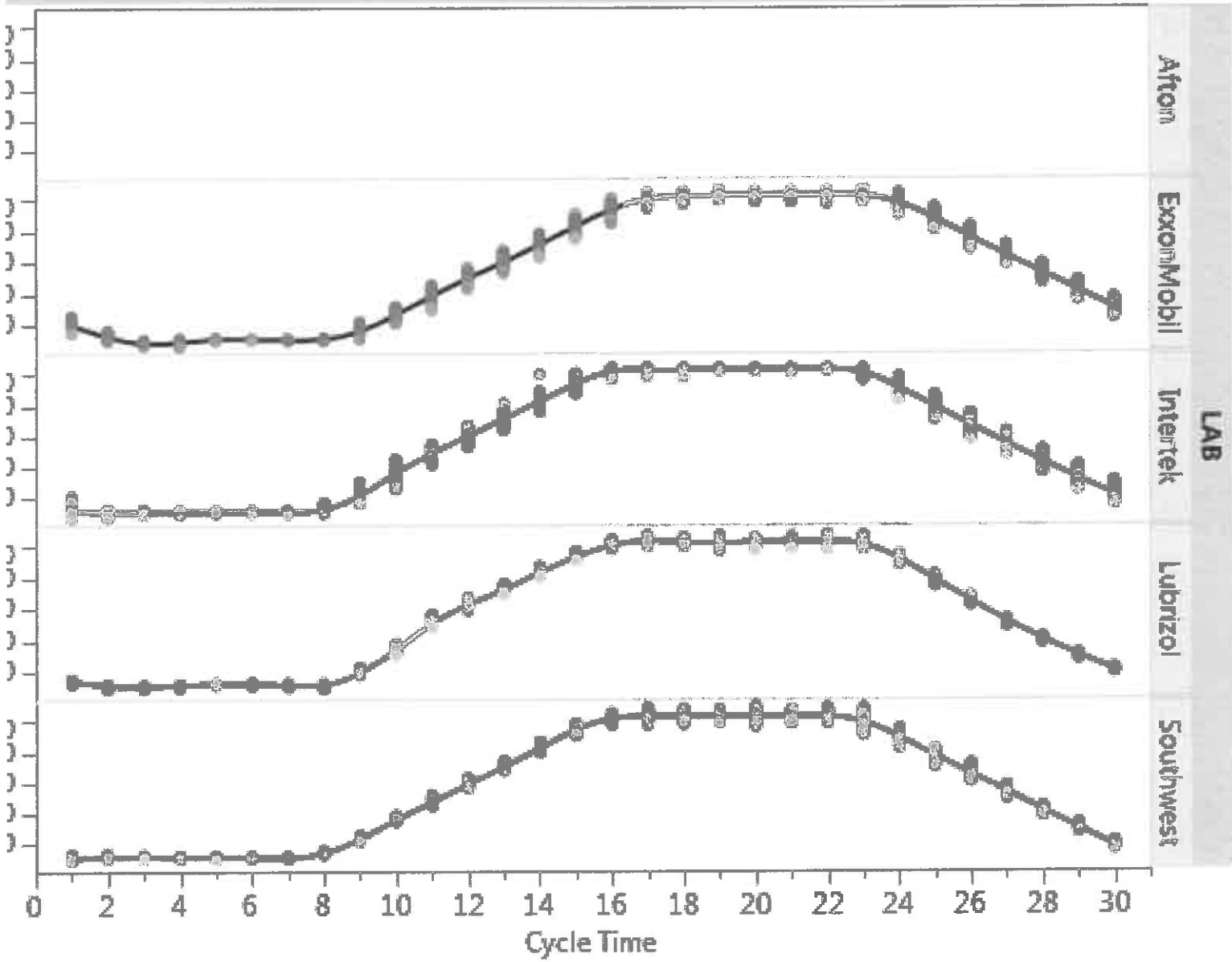


(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Power vs. Cycle Time

r = Hr10-11



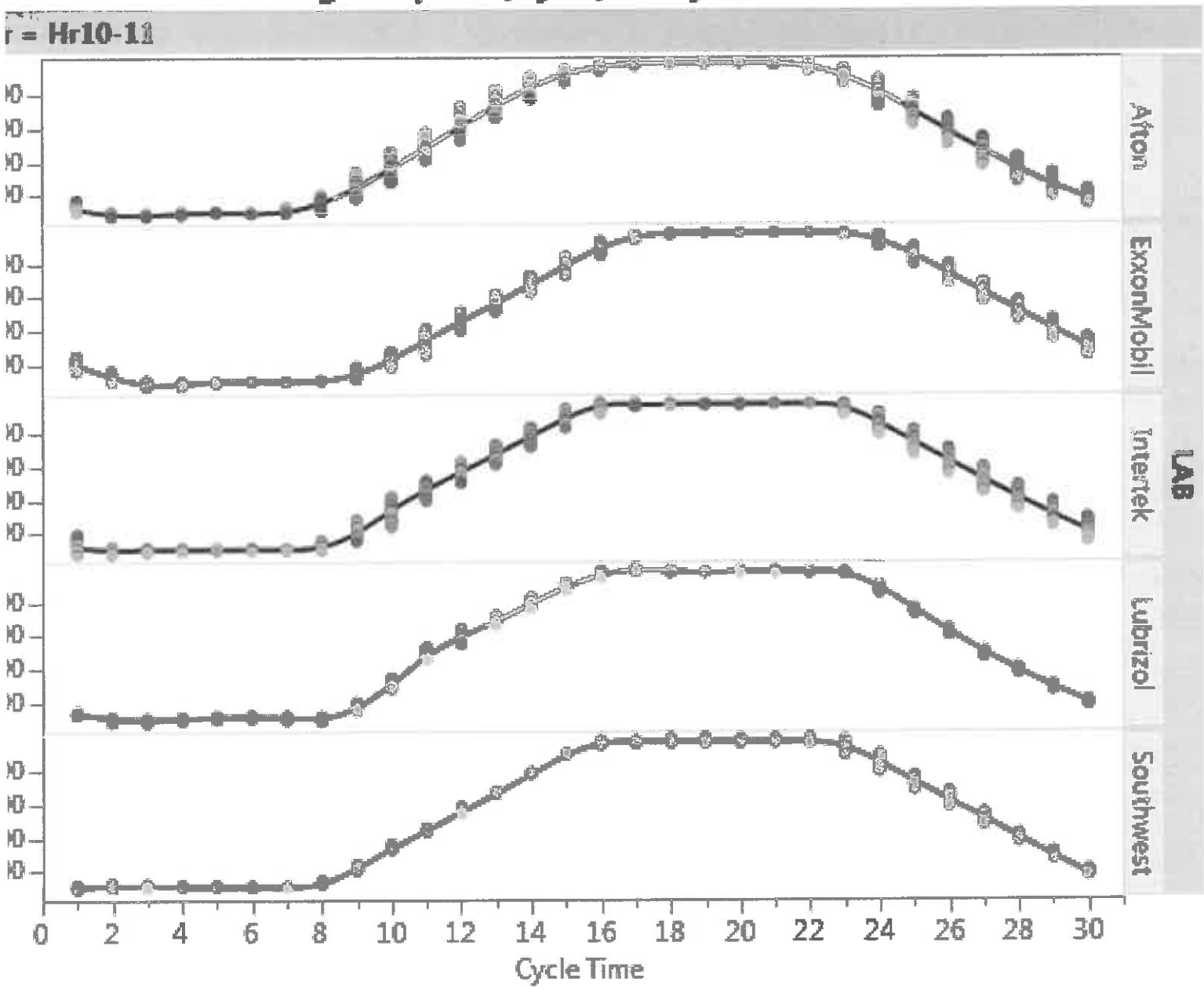
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Speed (Dyno) vs. Cycle Time



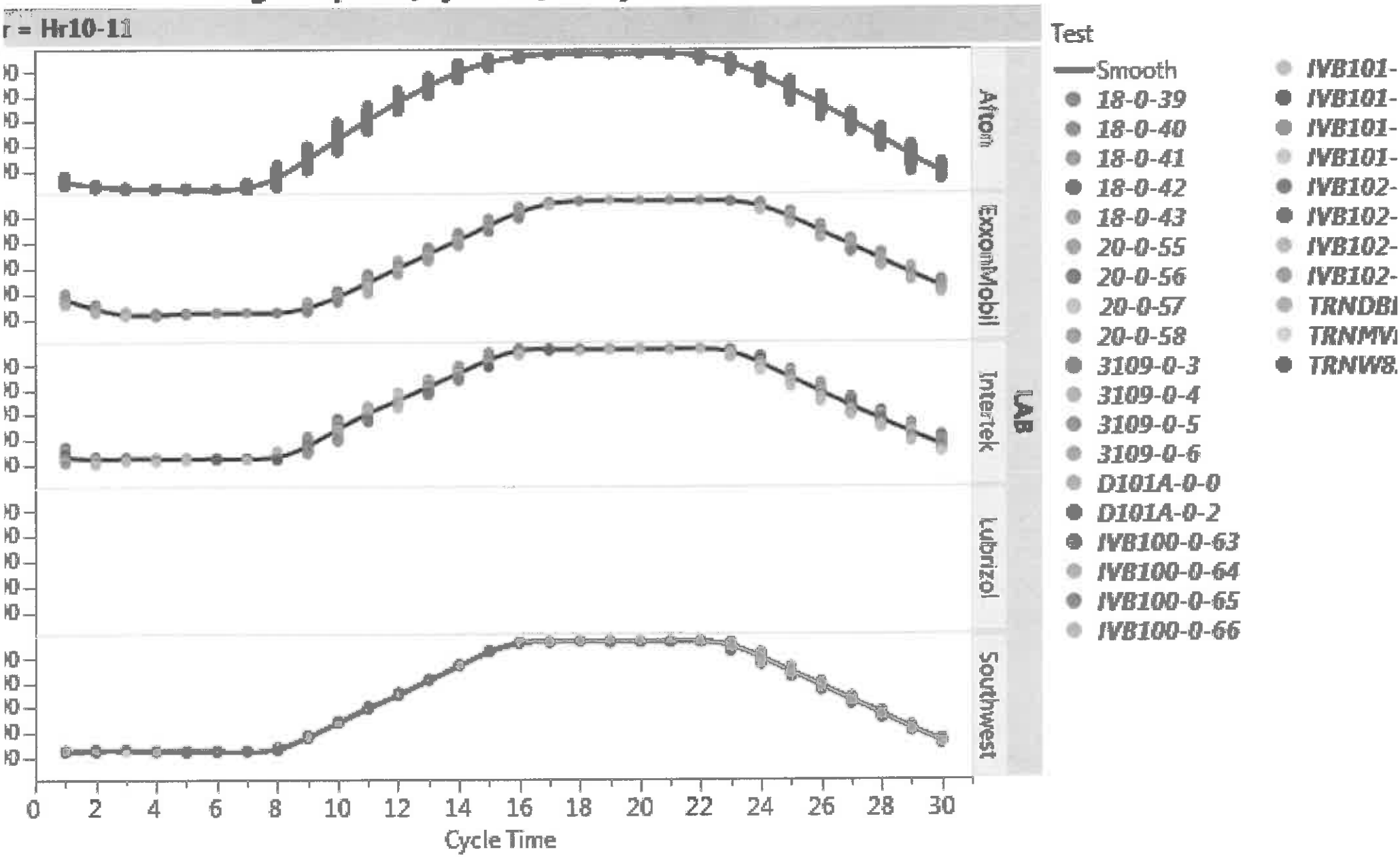
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Speed (Flywheel) vs. Cycle Time

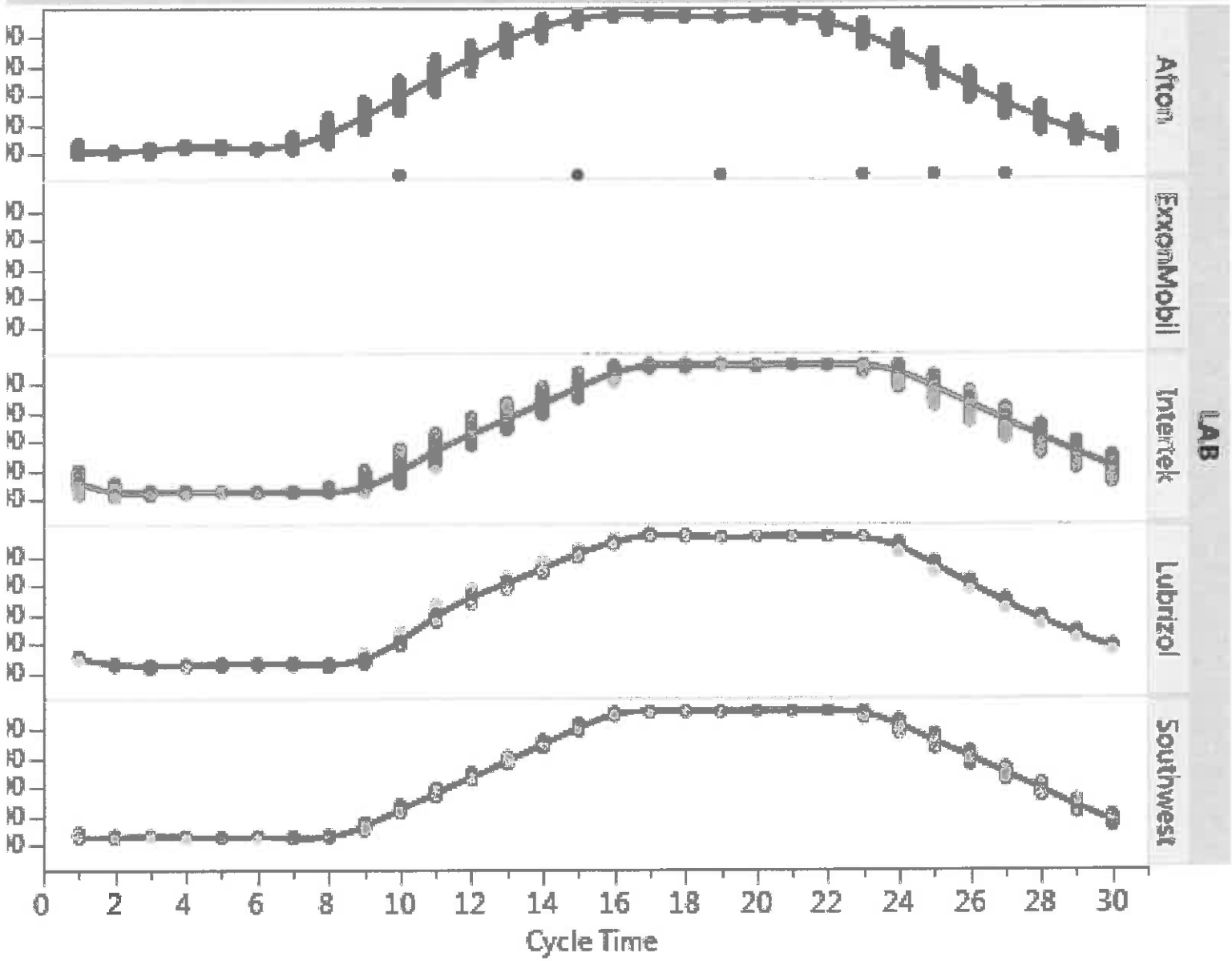


(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Speed vs. Cycle Time

r = Hr10-11



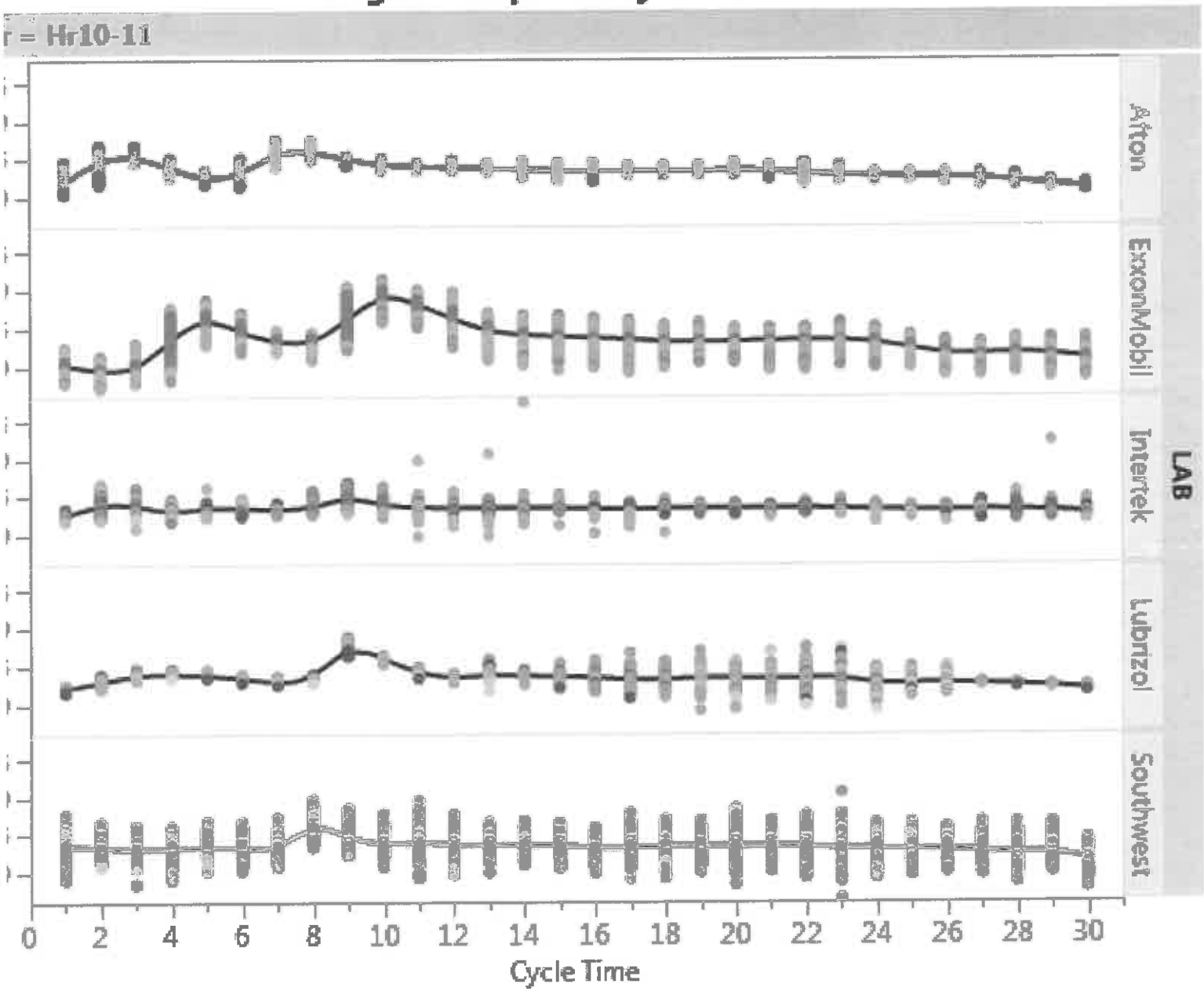
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Torque vs. Cycle Time



Test

Smooth

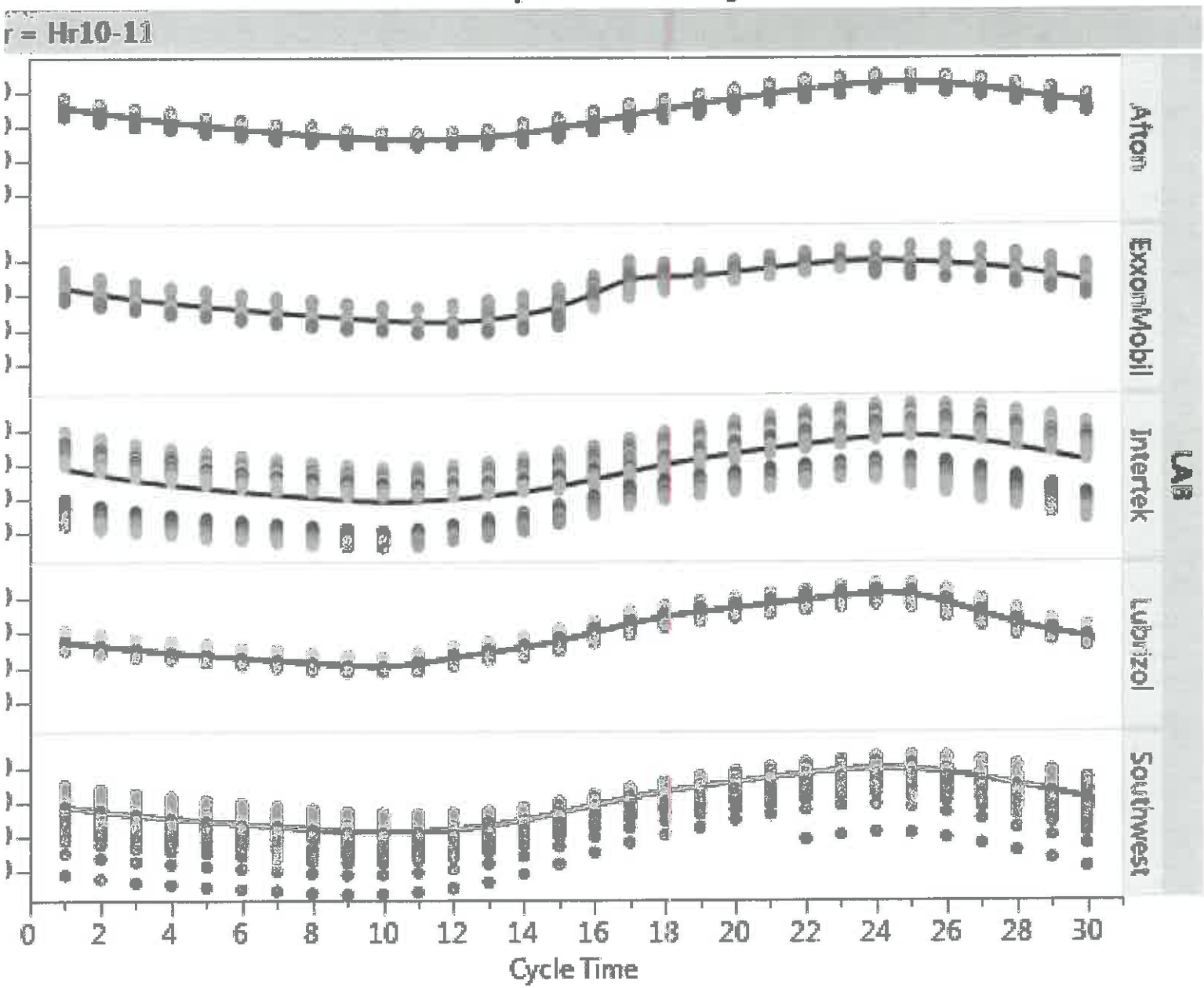
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Exhaust Gas Temperature vs. Cycle Time

r = Hr10-11



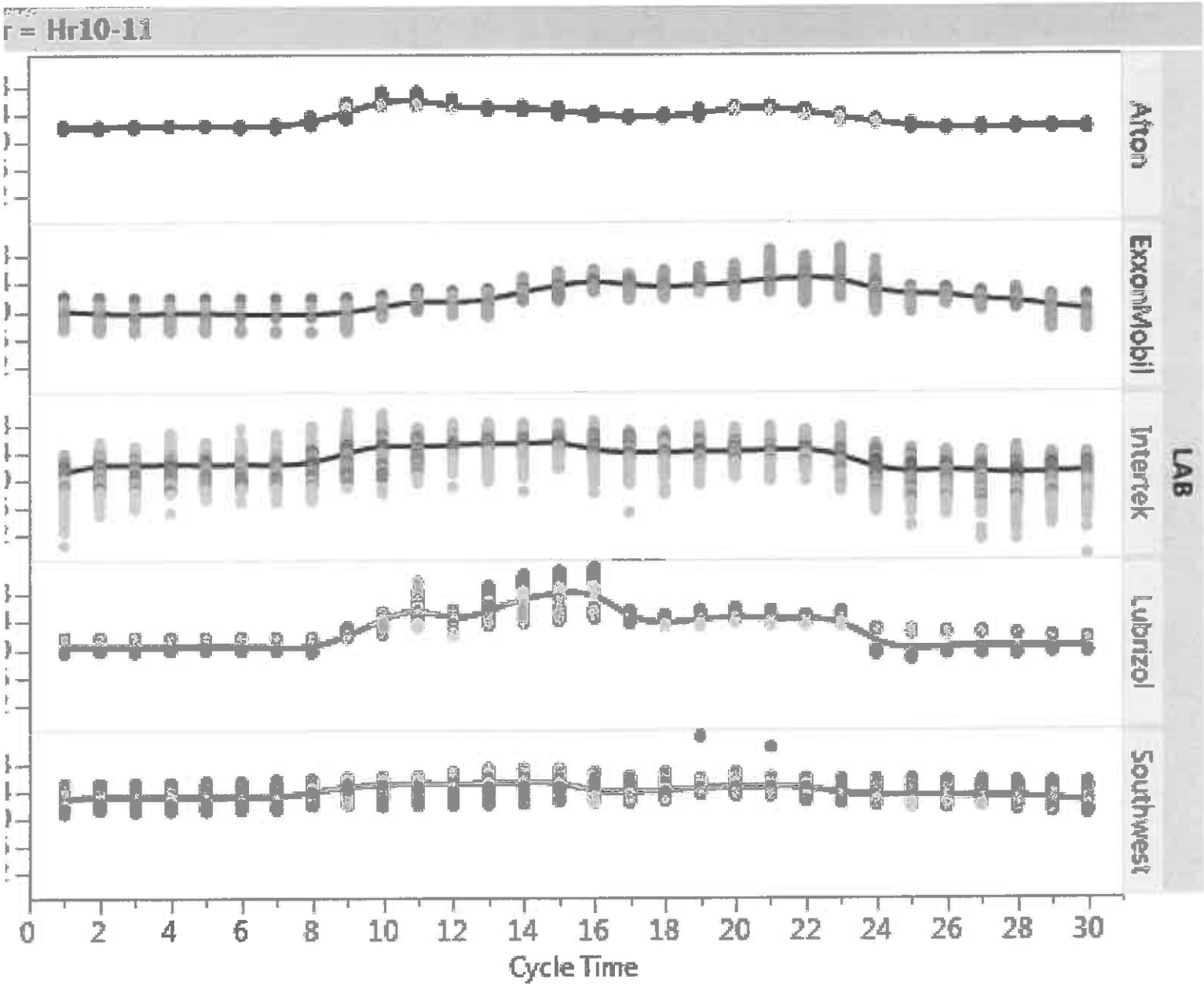
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Exhaust Pressure vs. Cycle Time



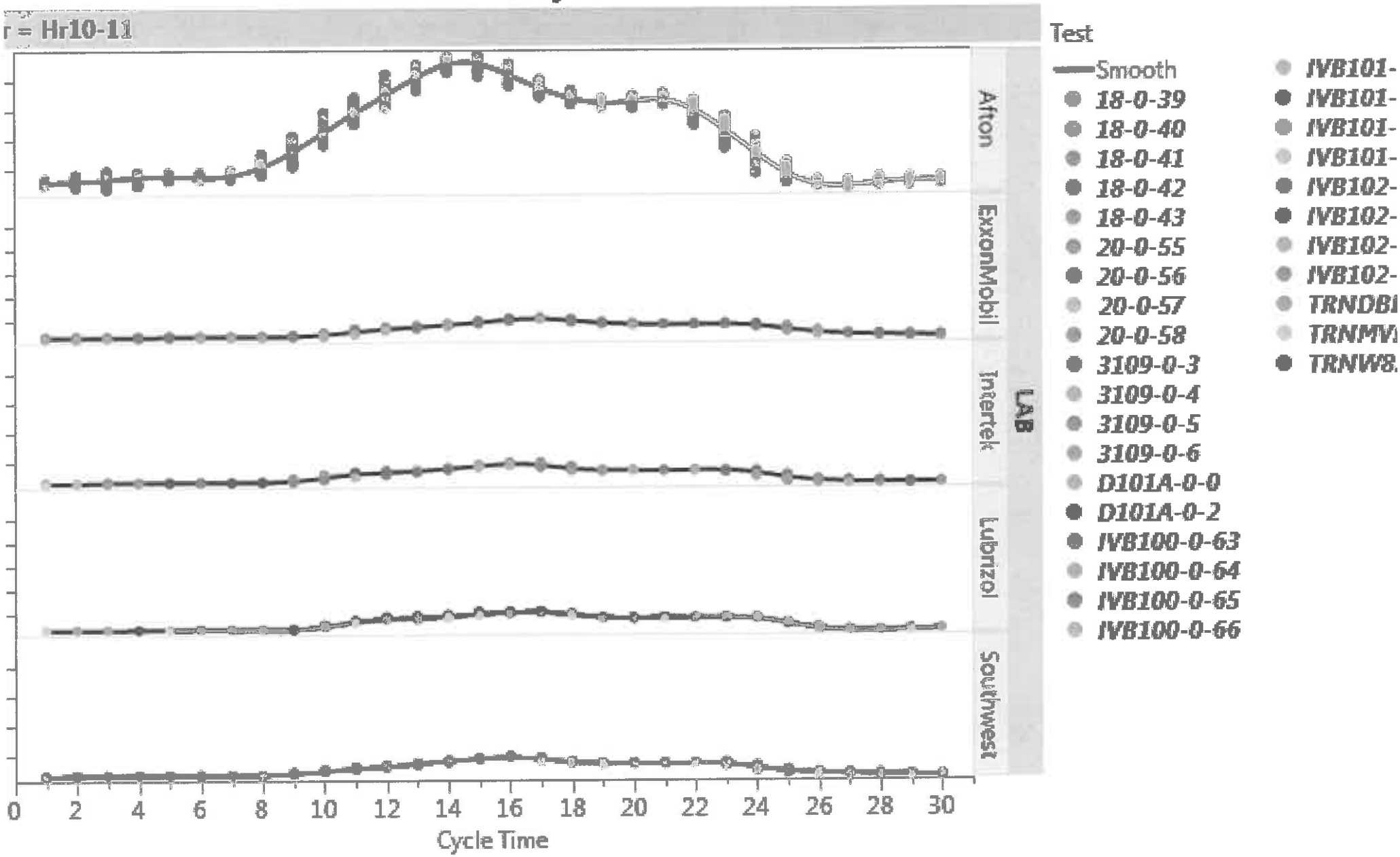
Test

- Smooth
- *18-0-39*
- *18-0-40*
- *18-0-41*
- *18-0-42*
- *18-0-43*
- *20-0-55*
- *20-0-56*
- *20-0-57*
- *20-0-58*
- *3109-0-3*
- *3109-0-4*
- *3109-0-5*
- *3109-0-6*
- *D101A-0-0*
- *D101A-0-2*
- *IVB100-0-63*
- *IVB100-0-64*
- *IVB100-0-65*
- *IVB100-0-66*
- *IVB101-*
- *IVB101-*
- *IVB101-*
- *IVB101-*
- *IVB102-*
- *IVB102-*
- *IVB102-*
- *IVB102-*
- *TRNDBI*
- *TRNMVI*
- *TRNW8.*

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

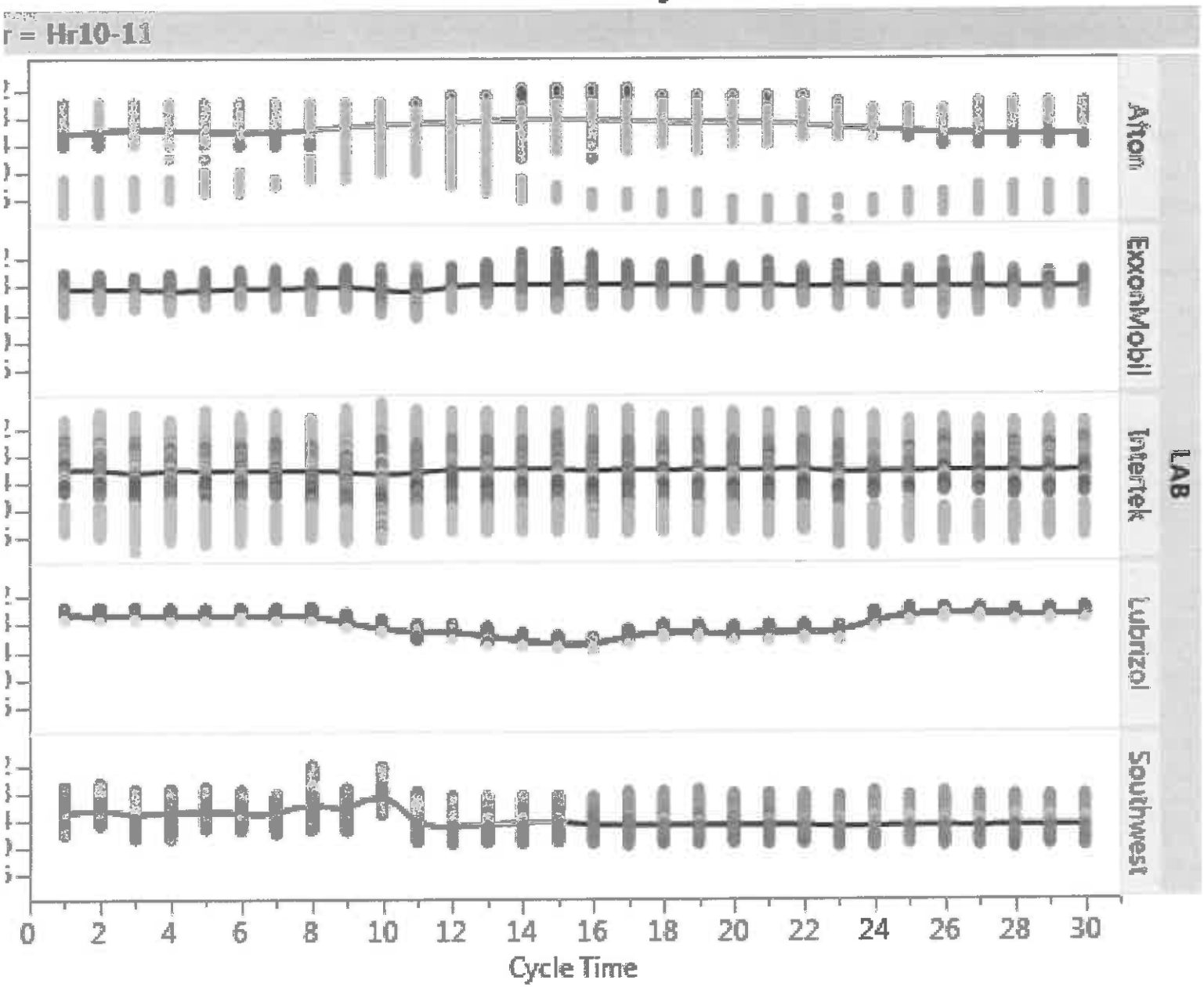
Fuel Flow Rate vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Fuel Rail Pressure vs. Cycle Time



Test

Smooth

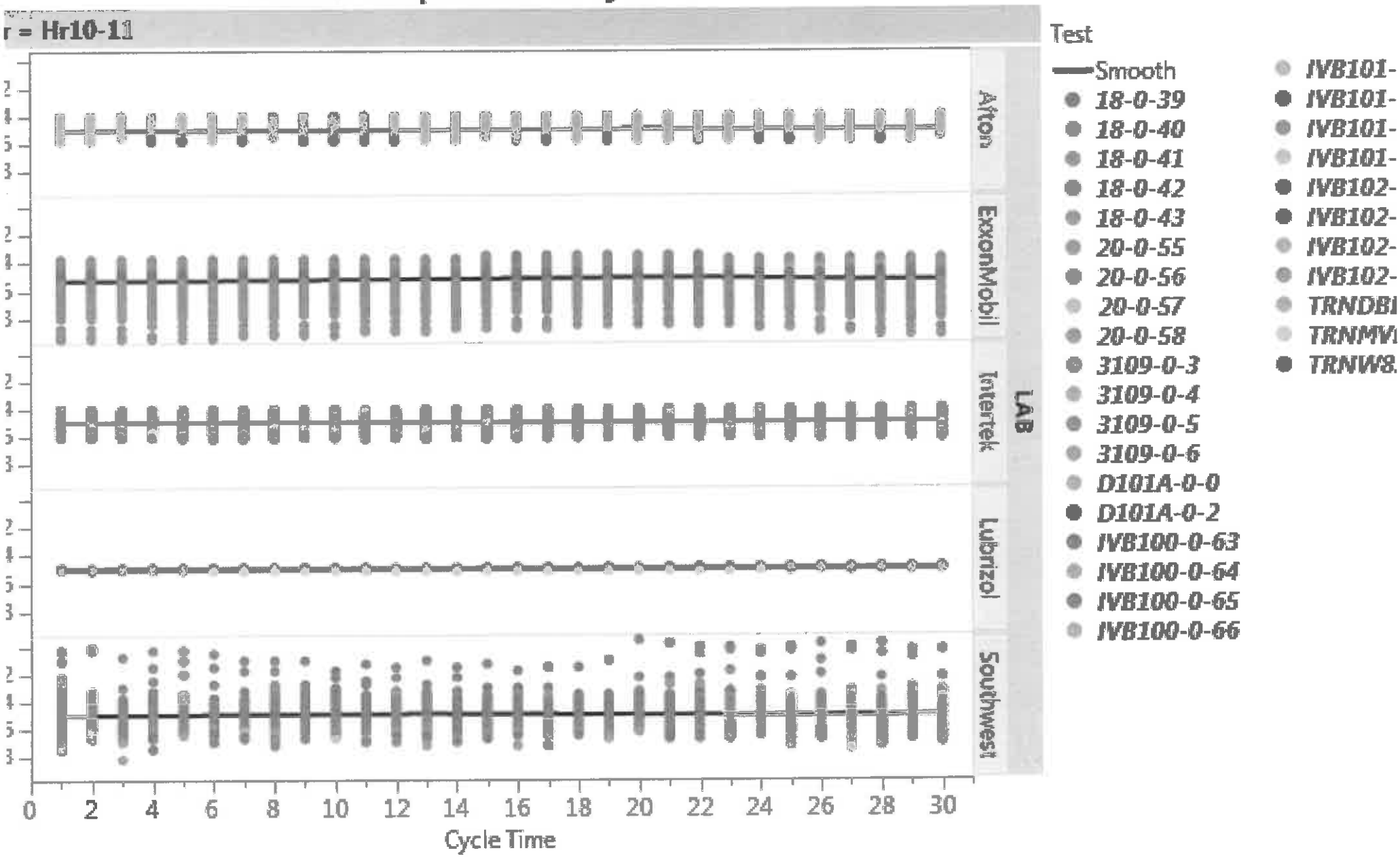
18-0-39
18-0-40
18-0-41
18-0-42
18-0-43
20-0-55
20-0-56
20-0-57
20-0-58
3109-0-3
3109-0-4
3109-0-5
3109-0-6
D101A-0-0
D101A-0-2
IVB100-0-63
IVB100-0-64
IVB100-0-65
IVB100-0-66

IVB101-
IVB101-
IVB101-
IVB101-
IVB102-
IVB102-
IVB102-
IVB102-
TRNDBI
TRNMVI
TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

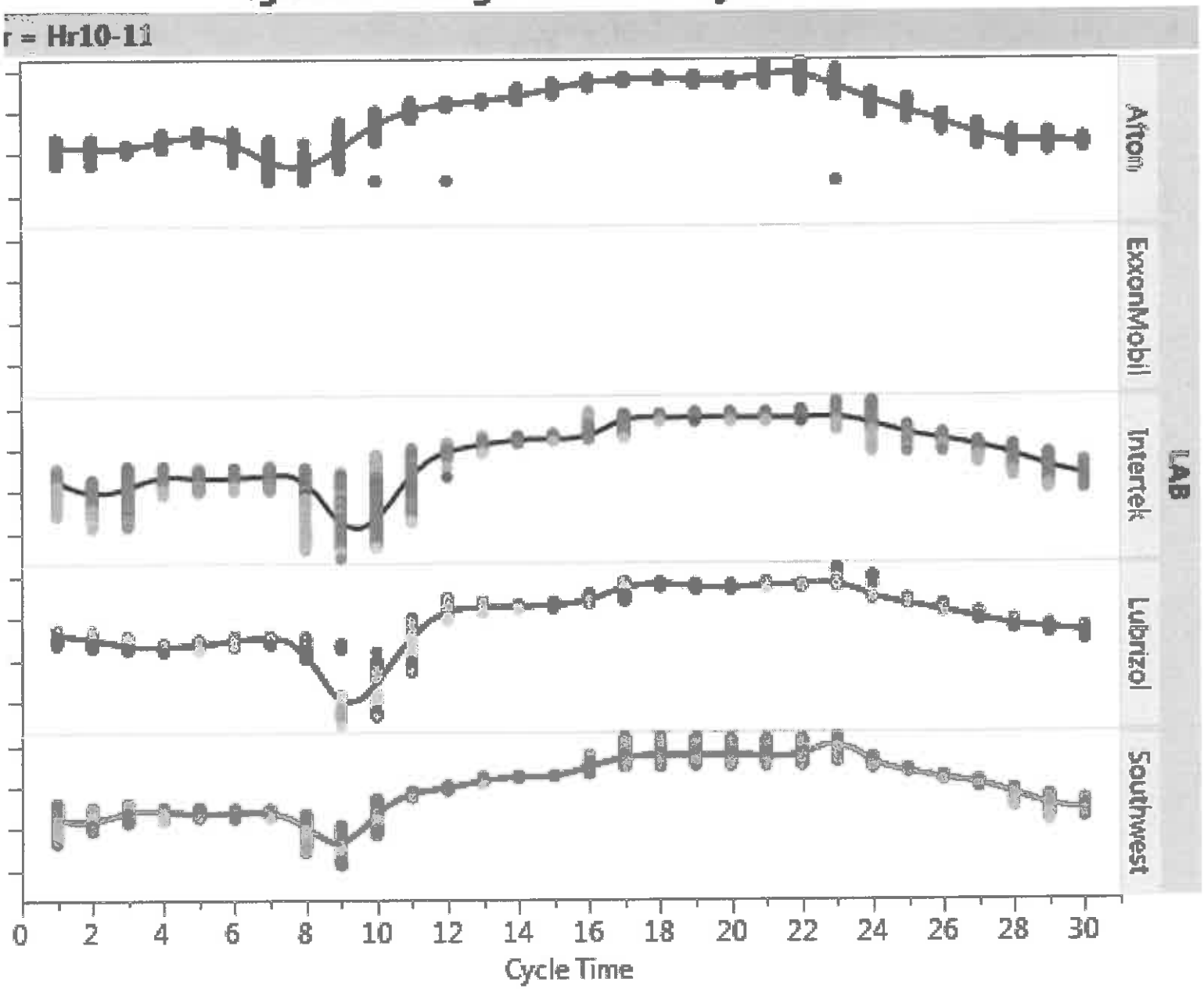
Fuel Rail Temperature vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Ignition Timing Advance vs. Cycle Time



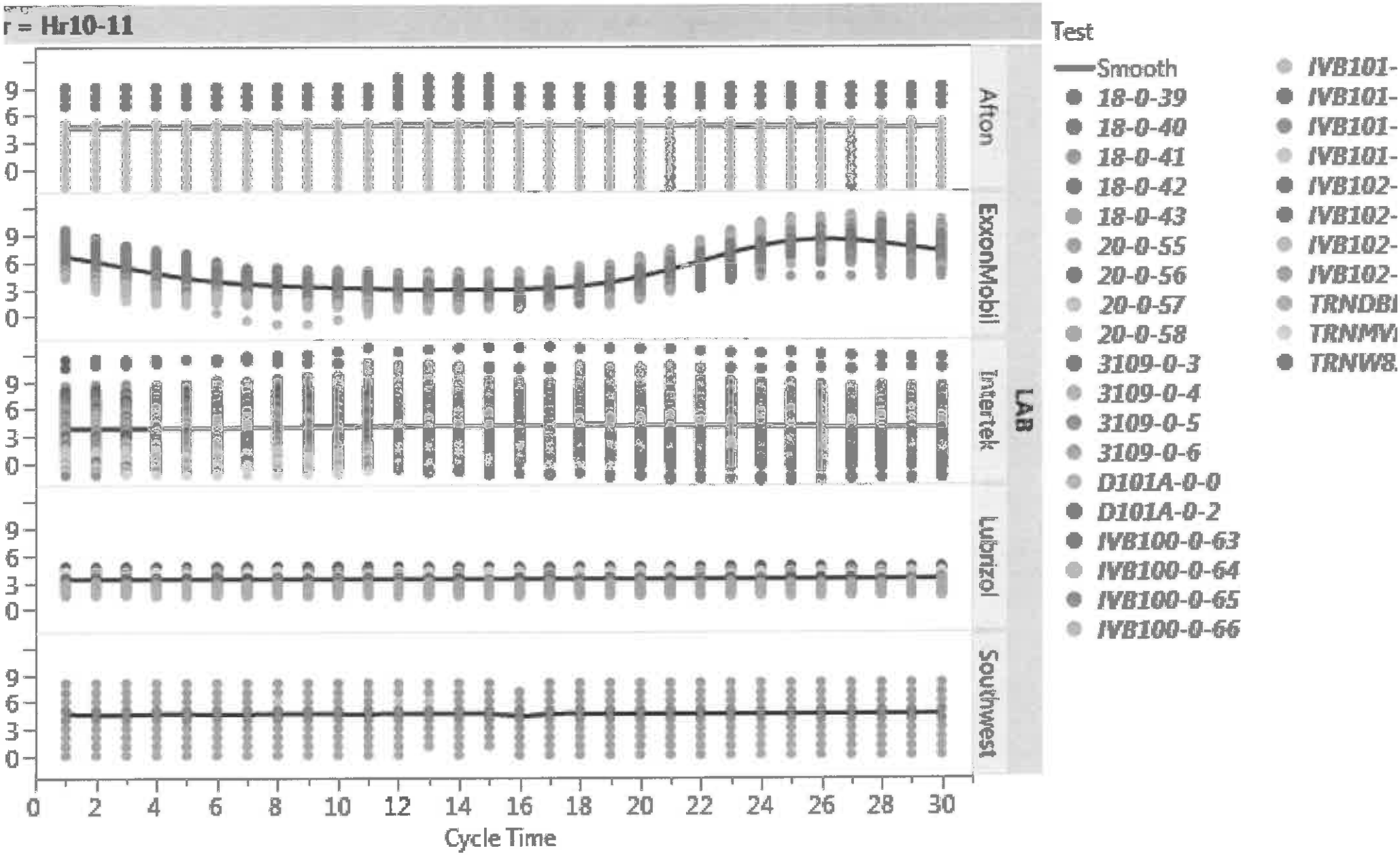
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

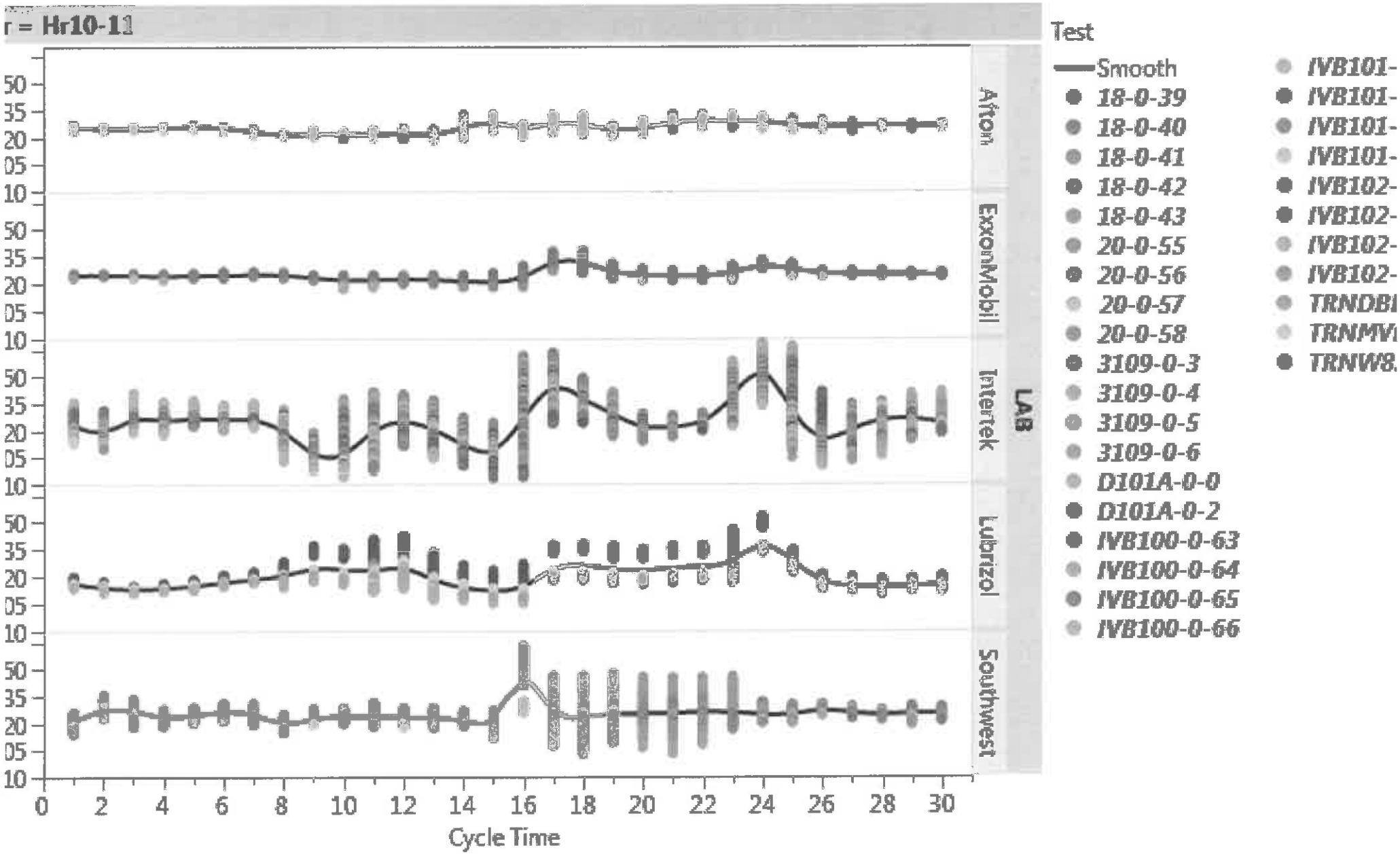
Intake Air Humidity vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

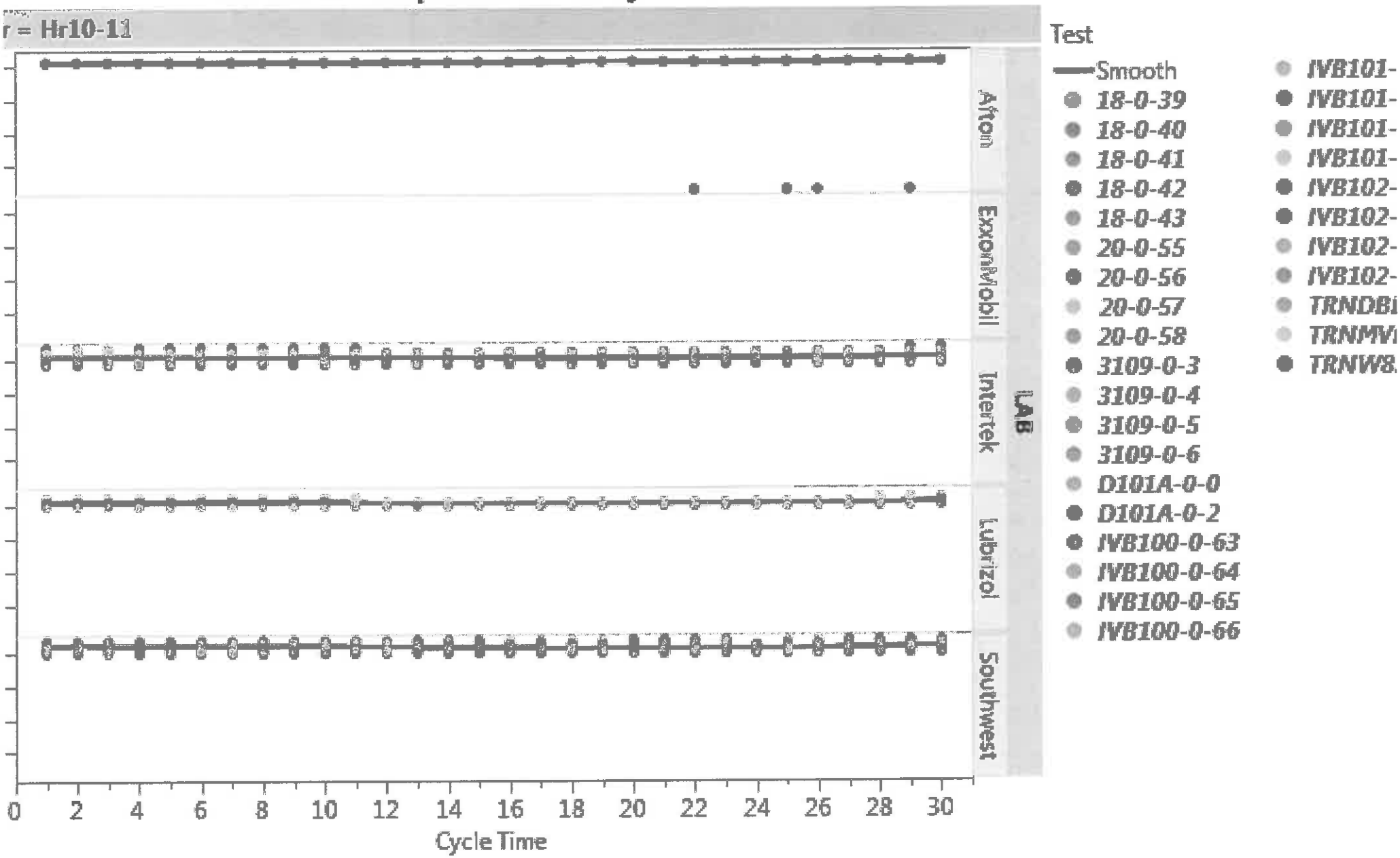
Intake Air Presure vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

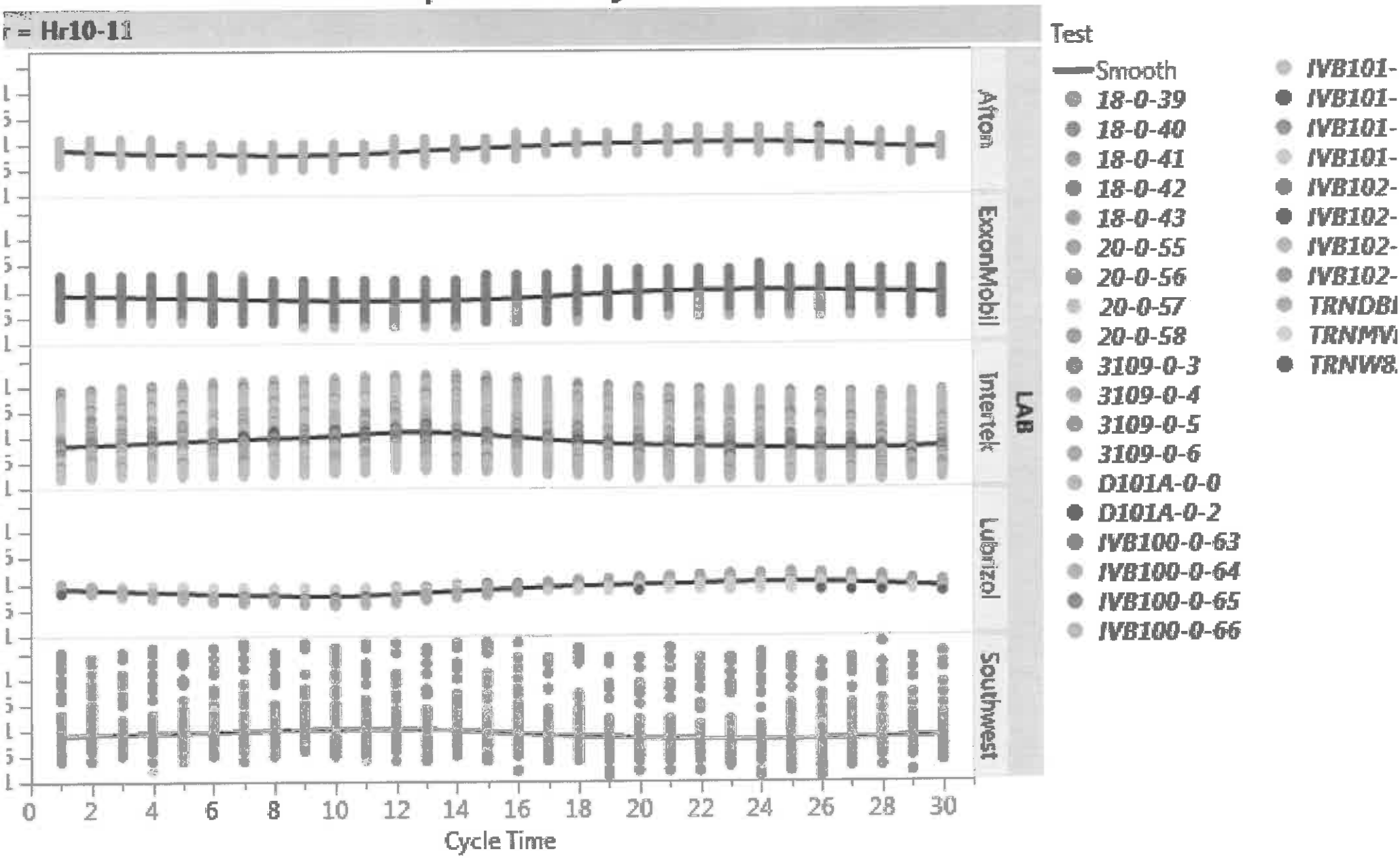
Intake Air Temperature 2 vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Air Temperature vs. Cycle Time

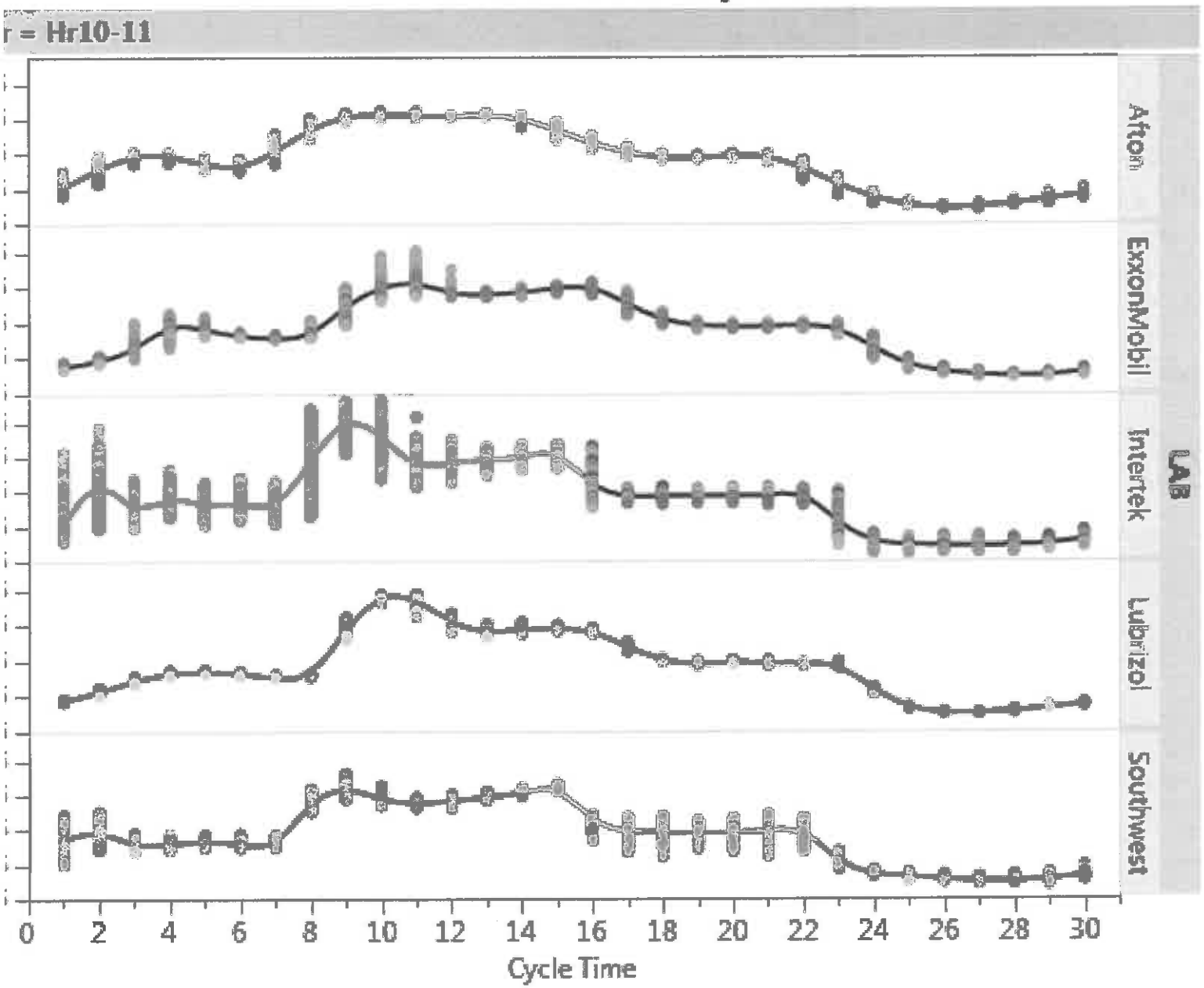


(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Manifold Pressure vs. Cycle Time

r = Hr10-11



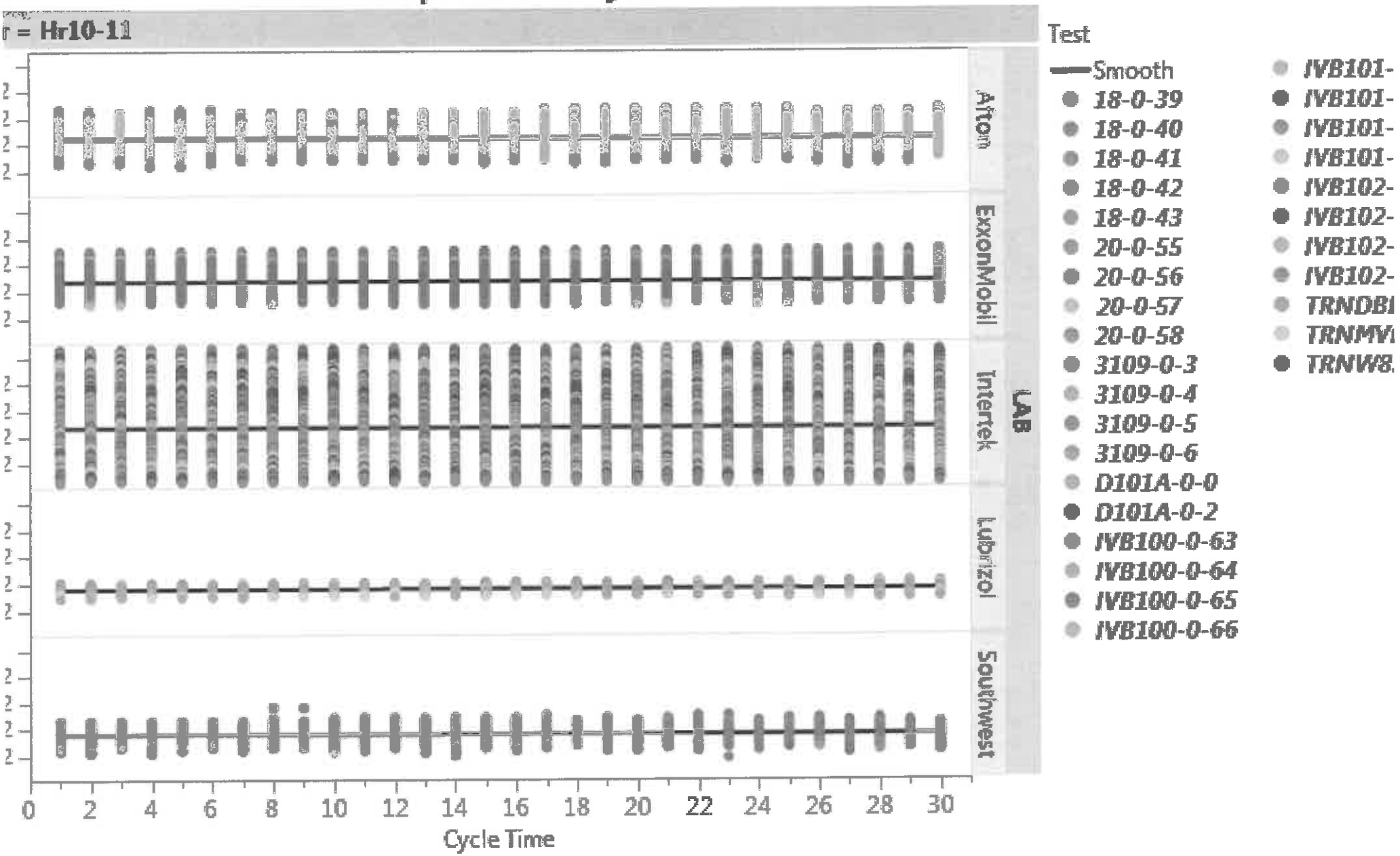
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNWB

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

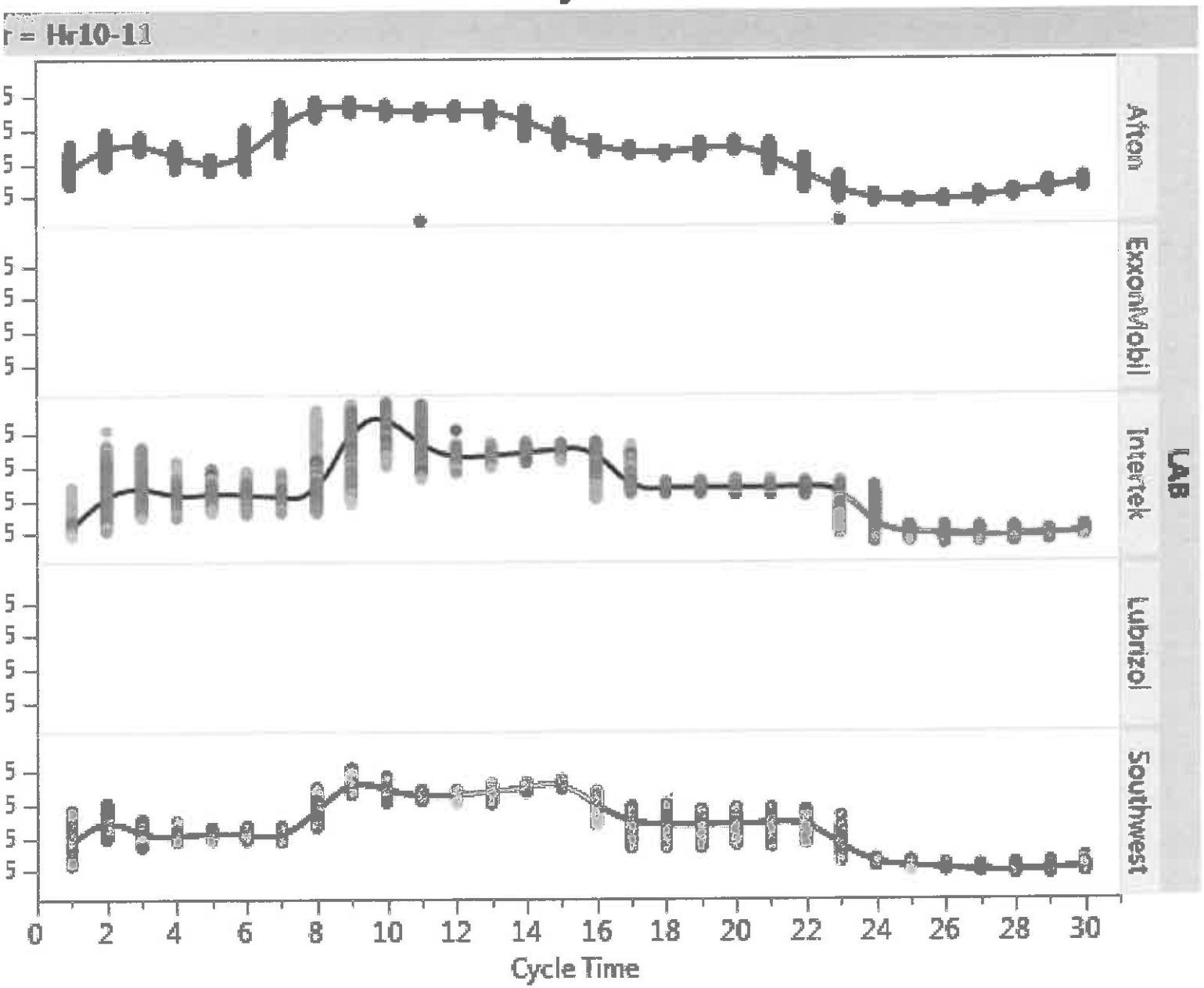
Load Cell Temperature vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

MAP vs. Cycle Time



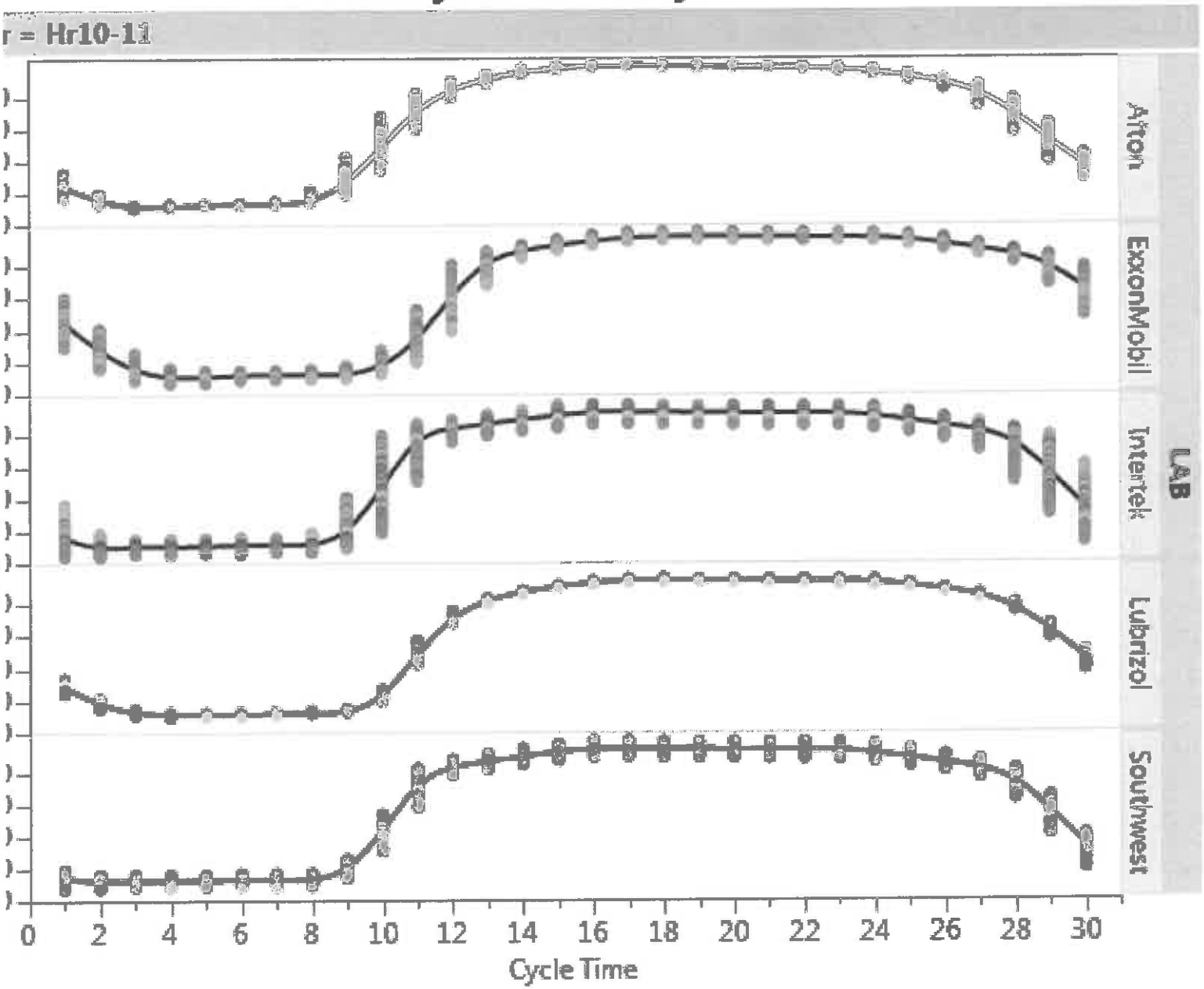
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Oil Gallery Pressure vs. Cycle Time



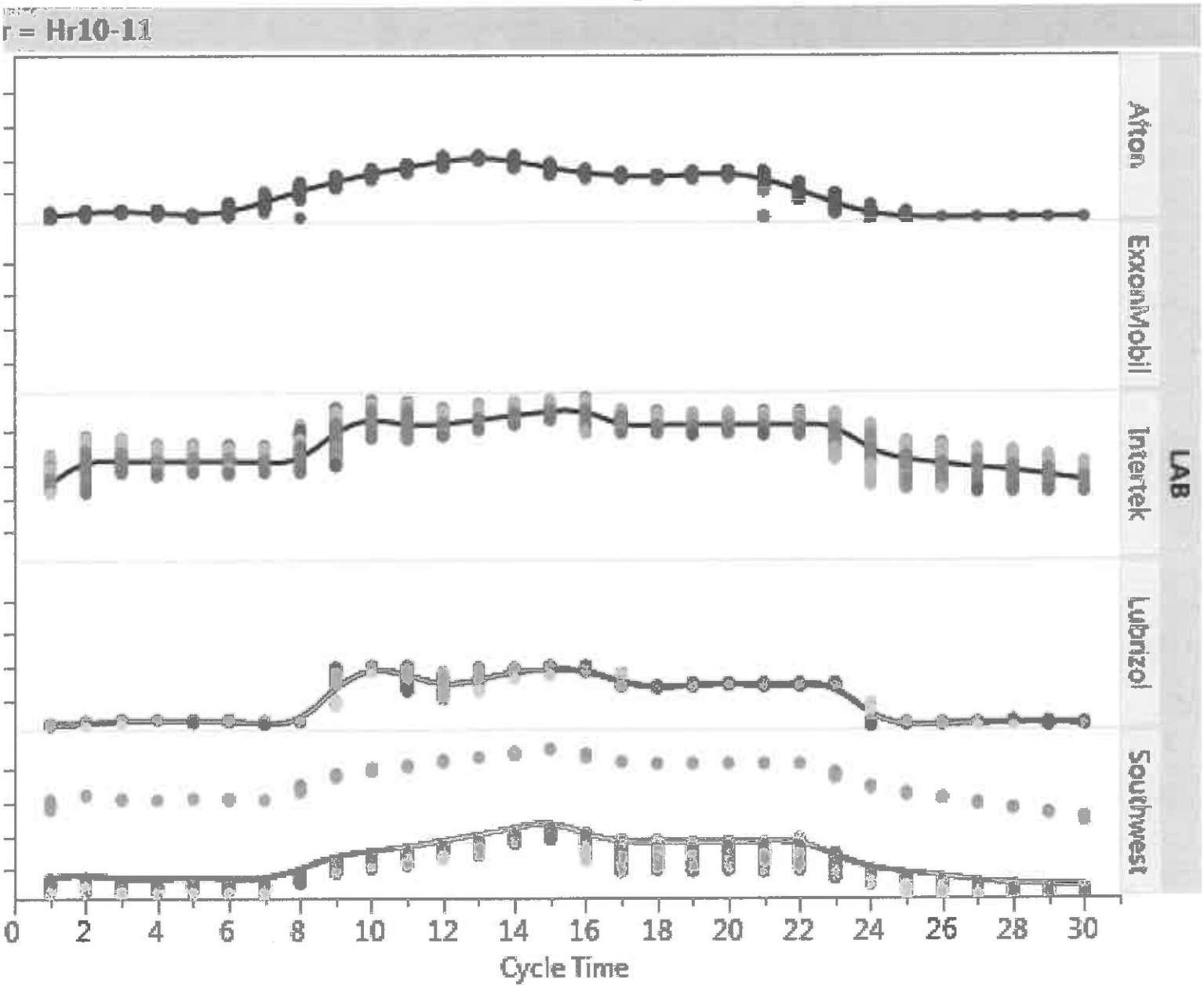
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Pedal Position vs. Cycle Time



Test

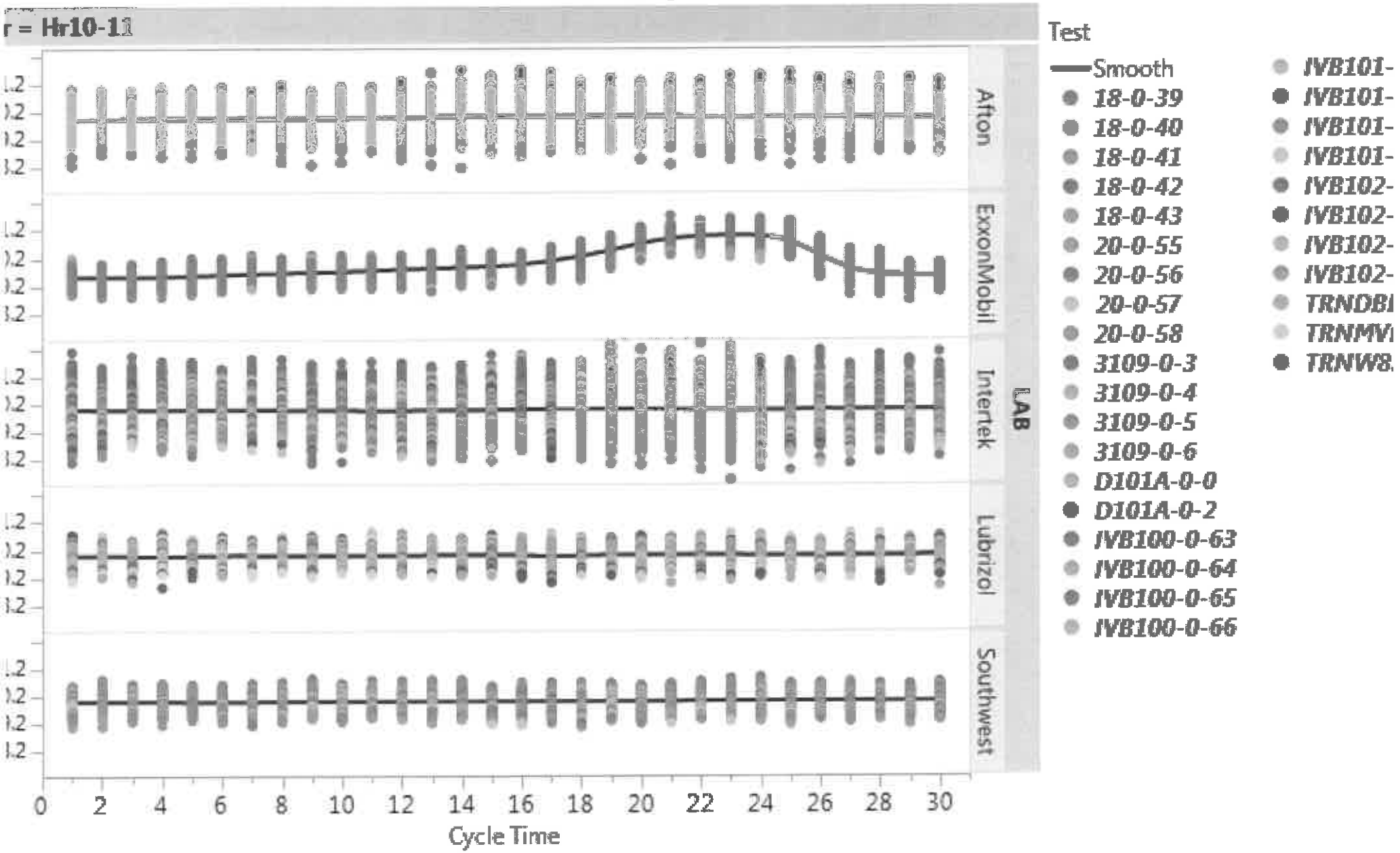
Smooth

18-0-39
18-0-40
18-0-41
18-0-42
18-0-43
20-0-55
20-0-56
20-0-57
20-0-58
3109-0-3
3109-0-4
3109-0-5
3109-0-6
D101A-0-0
D101A-0-2
IVB100-0-63
IVB100-0-64
IVB100-0-65
IVB100-0-66

IVB101-
IVB101-
IVB101-
IVB101-
IVB102-
IVB102-
IVB102-
IVB102-
TRNDBI
TRNMVI
TRNW8

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

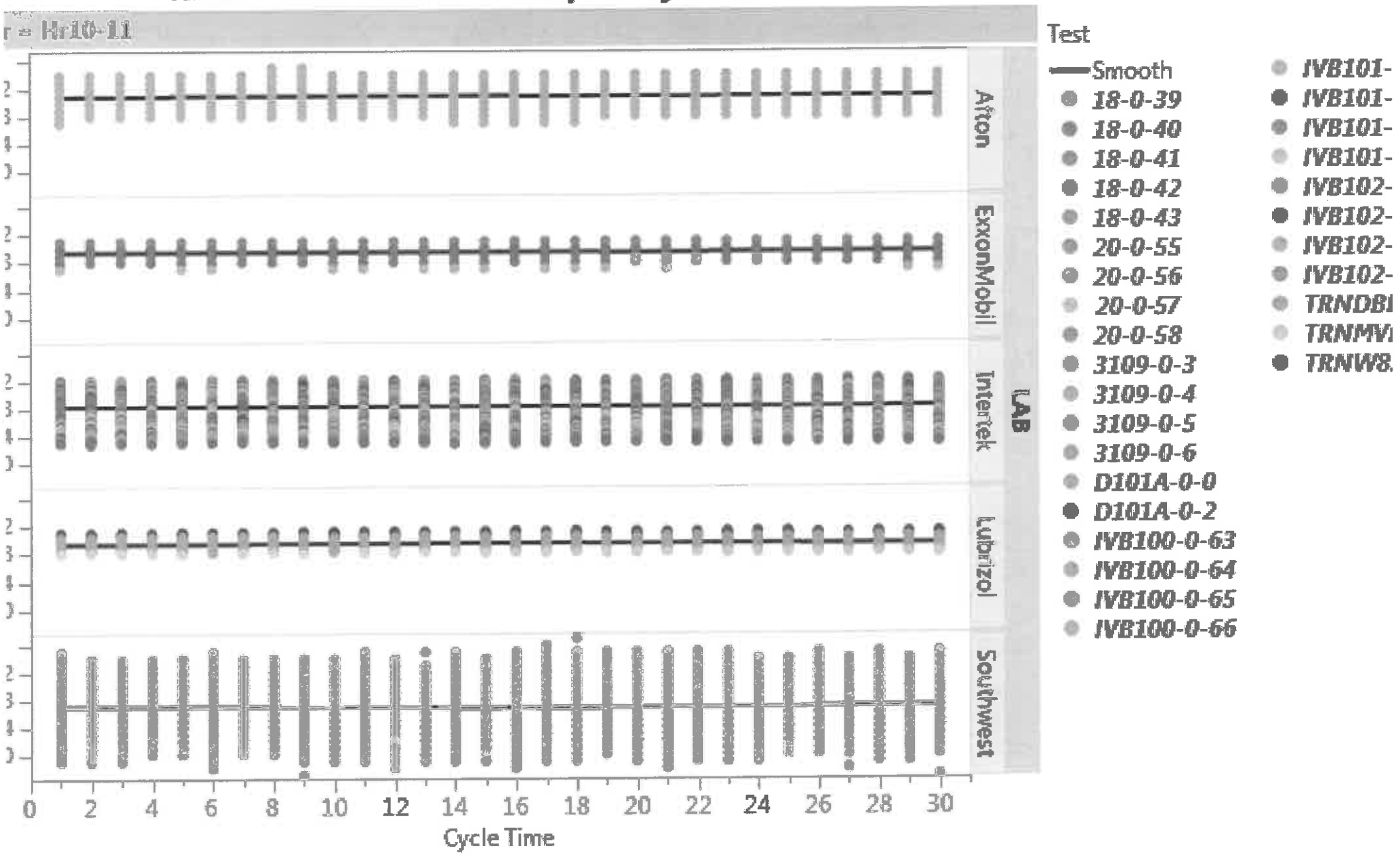
h Builder



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

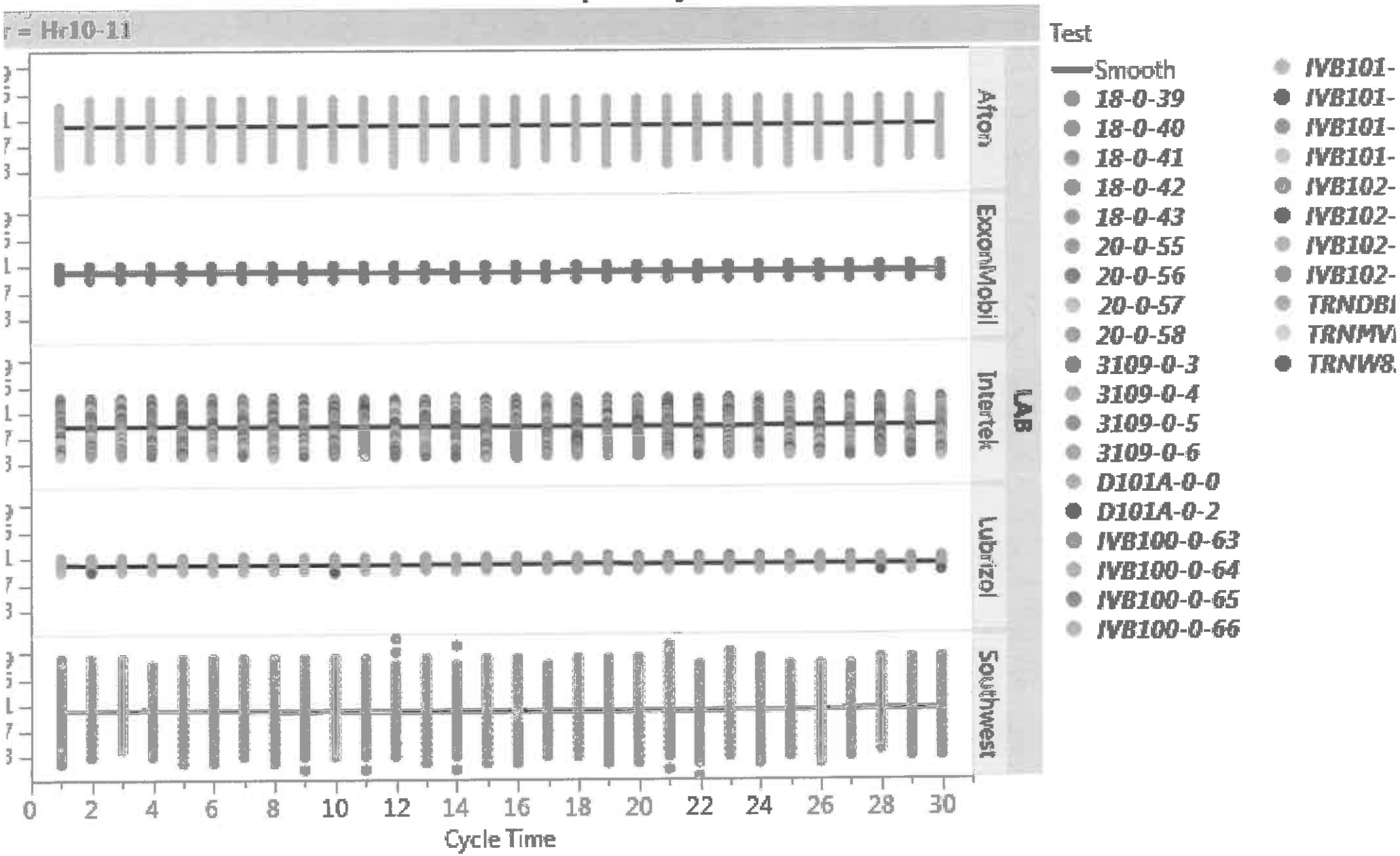
Rocker Cover Coolant In Temp. vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

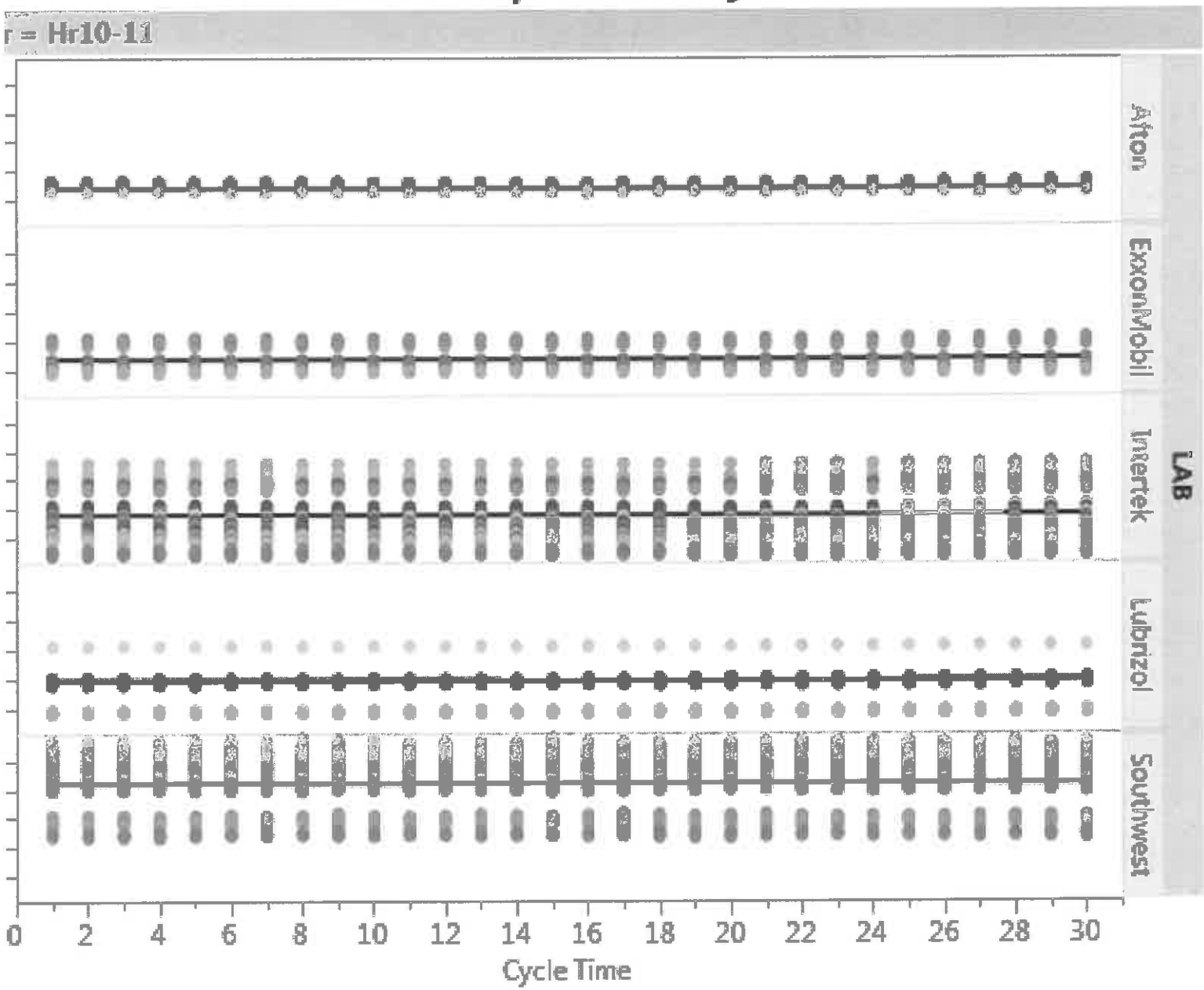
Rocker Cover Coolant Out Temp. vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Test Cell Air Temperature vs. Cycle Time



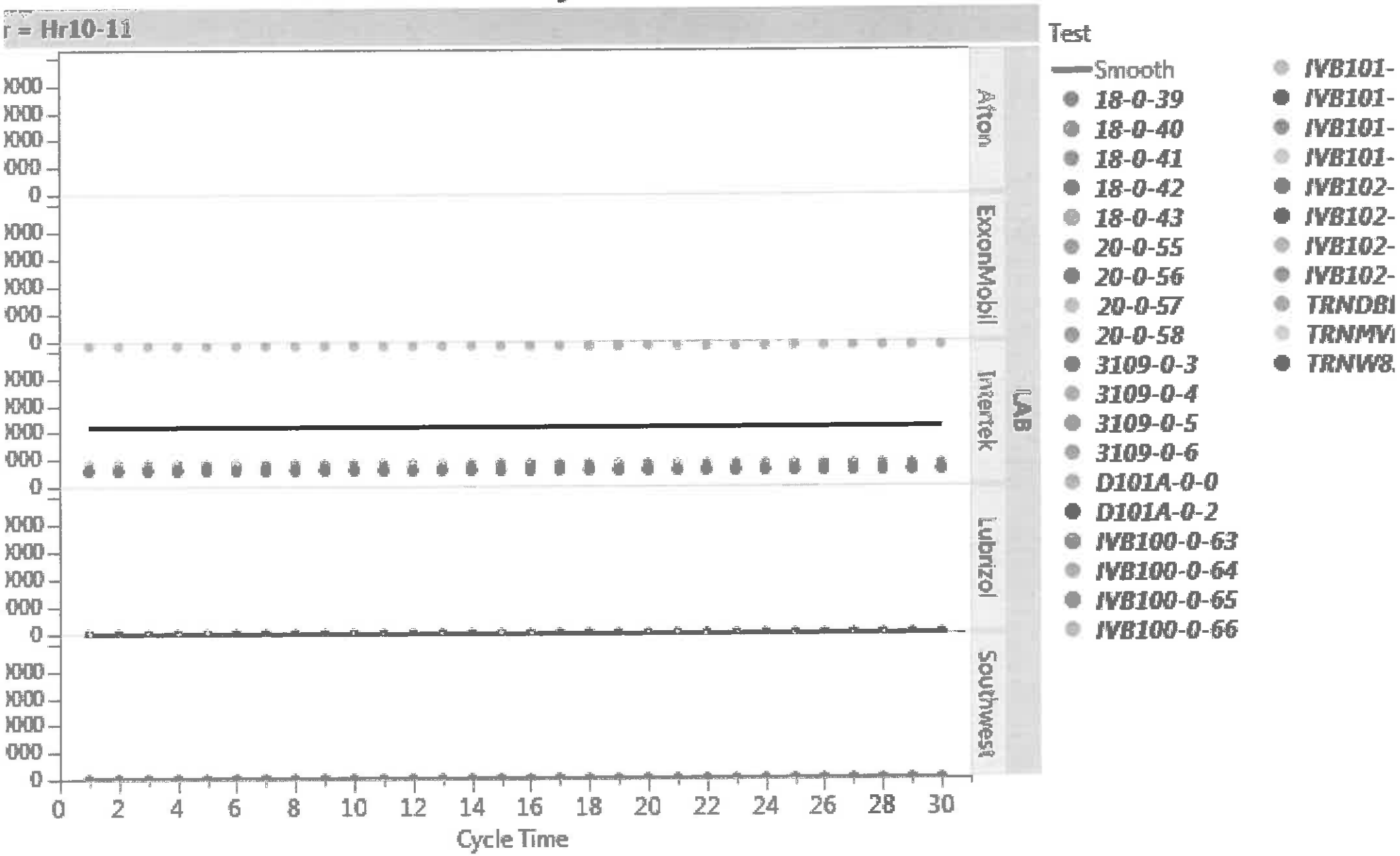
Test

Smooth
18-0-39
18-0-40
18-0-41
18-0-42
18-0-43
20-0-55
20-0-56
20-0-57
20-0-58
3109-0-3
3109-0-4
3109-0-5
3109-0-6
D101A-0-0
D101A-0-2
IVB100-0-63
IVB100-0-64
IVB100-0-65
IVB100-0-66
IVB101-
IVB101-
IVB101-
IVB101-
IVB102-
IVB102-
IVB102-
IVB102-
TRNDBI
TRNMVI
TRNW8.

(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

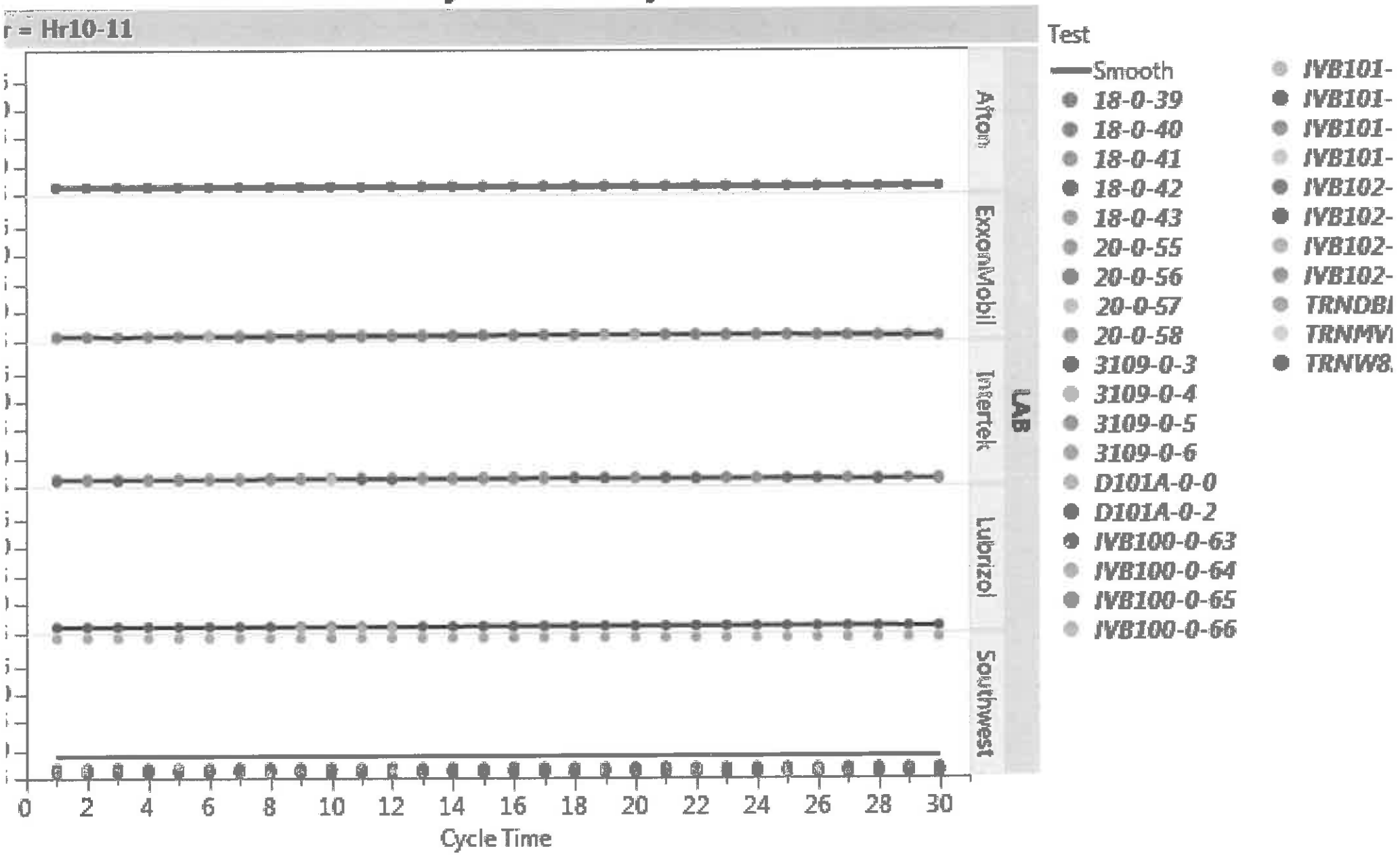
Total Fuel Used vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Valve Cover Blowby Gas Out vs. Cycle Time



(TestHr = Hr10-11) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

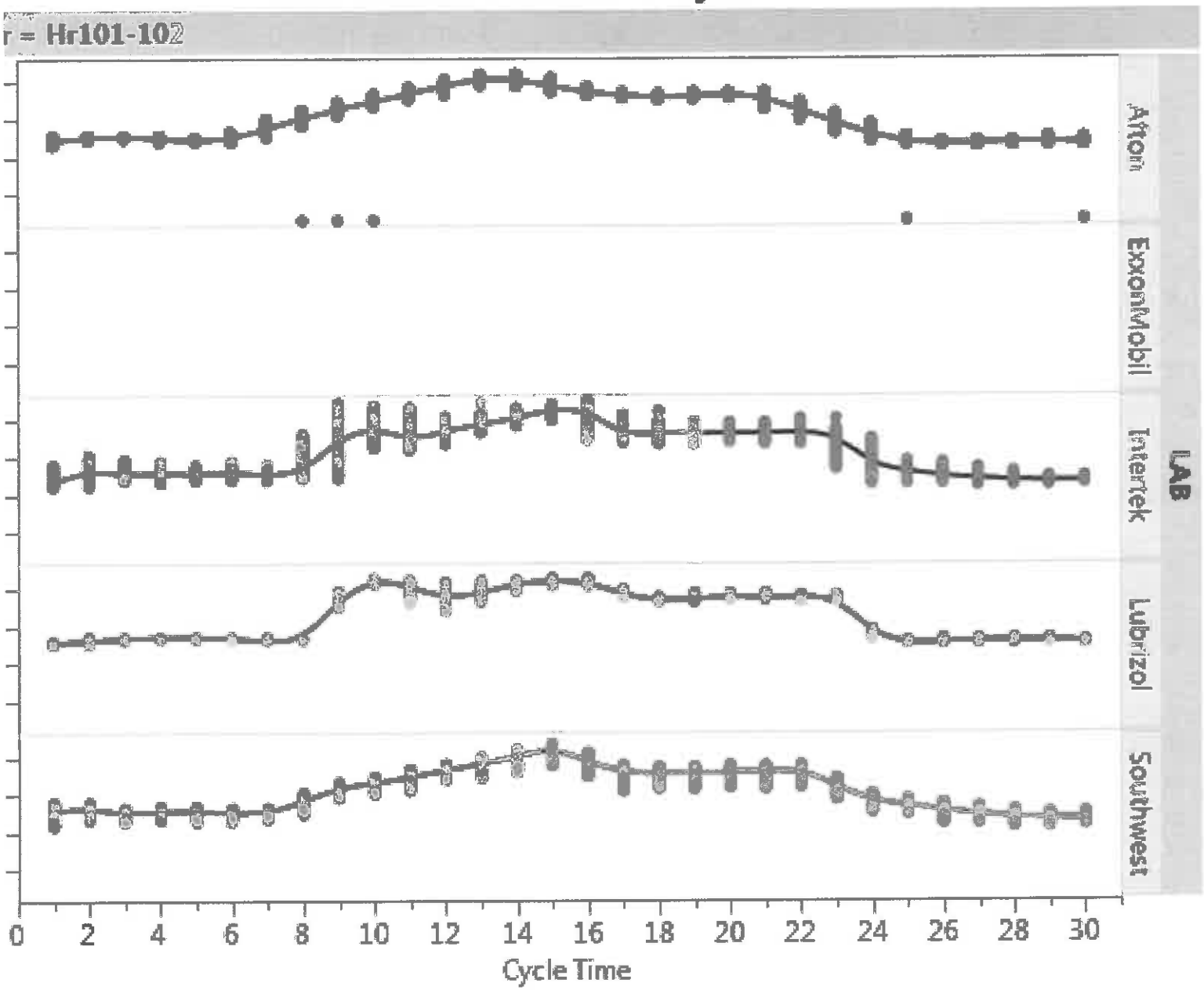
Operational Plots for All Labs Hrs 101-102, Exclusively

By: Stats Group

02-28-18

h Builder

Abs. Throttle Position vs. Cycle Time



Test

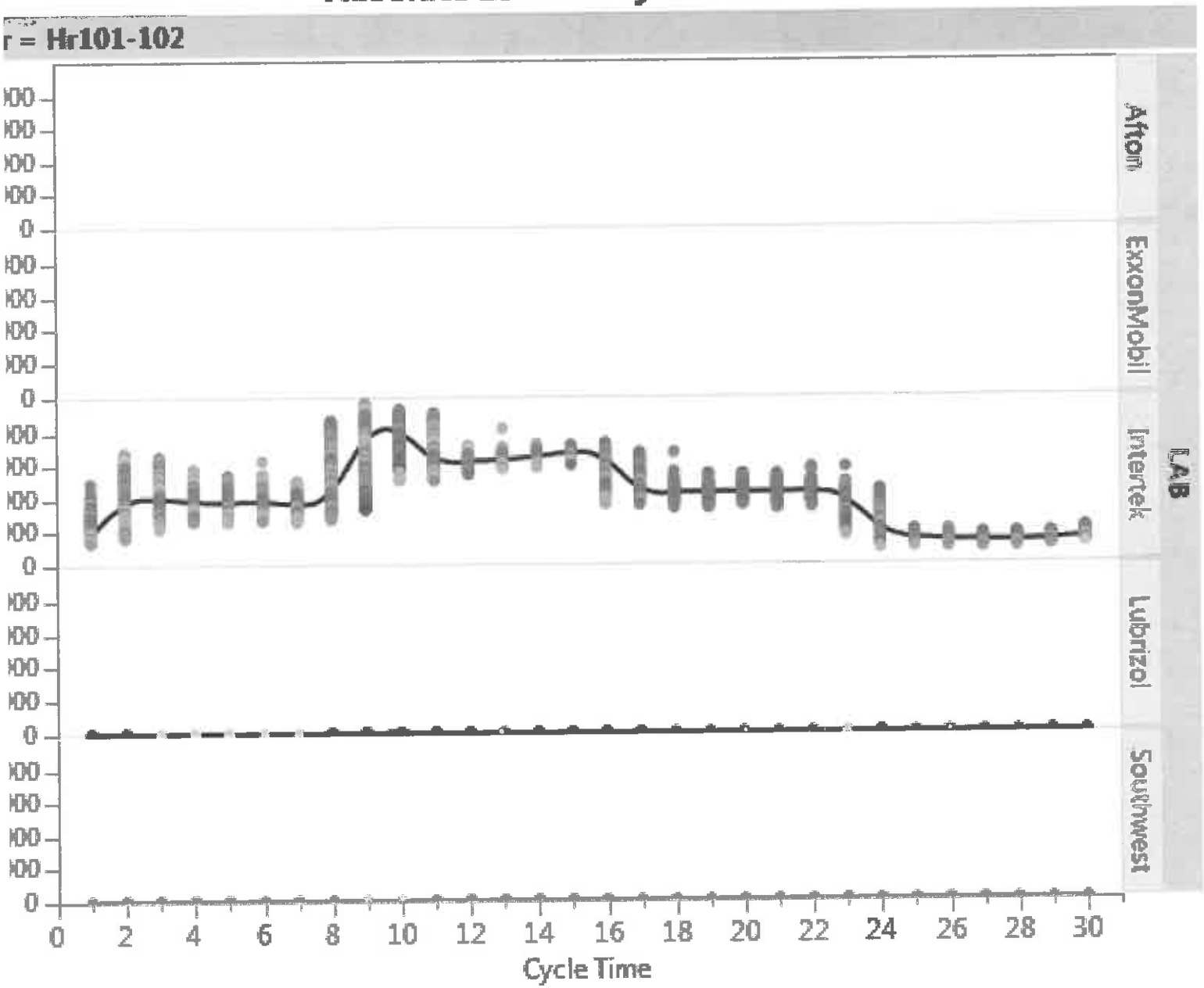
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Absolute Load vs. Cycle Time

r = Hr101-102



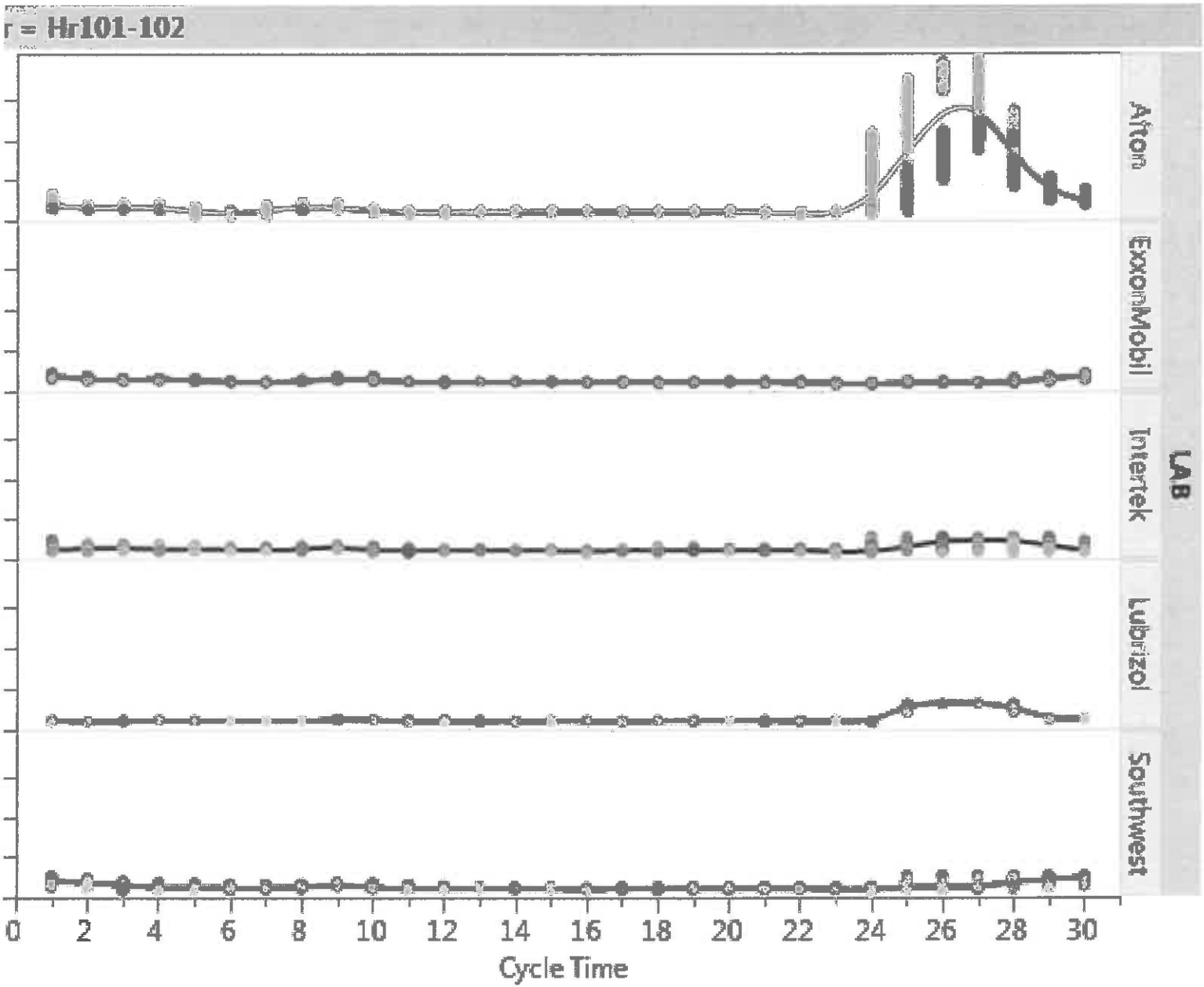
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Air Fuel Ratio vs. Cycle Time

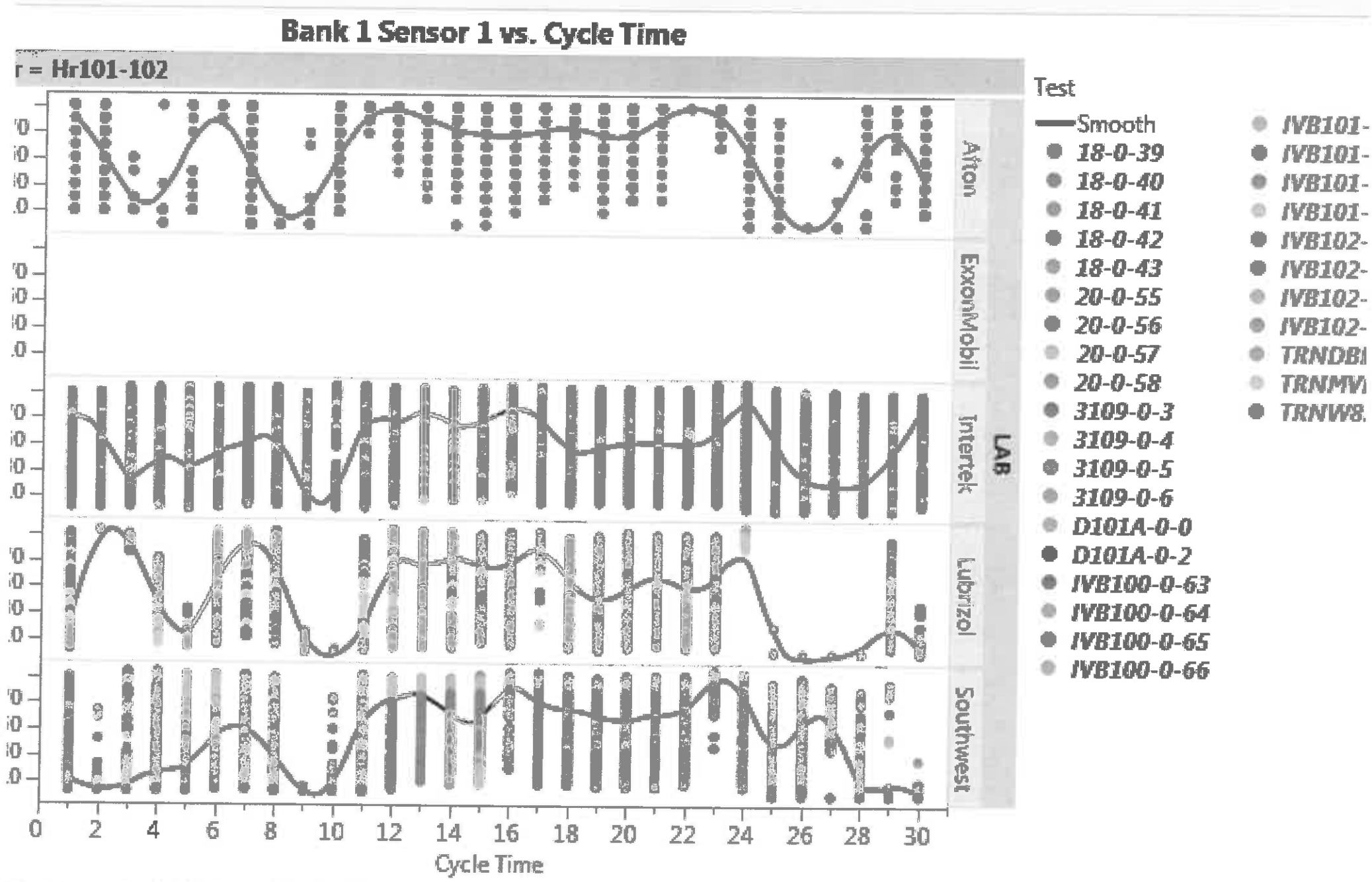


Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

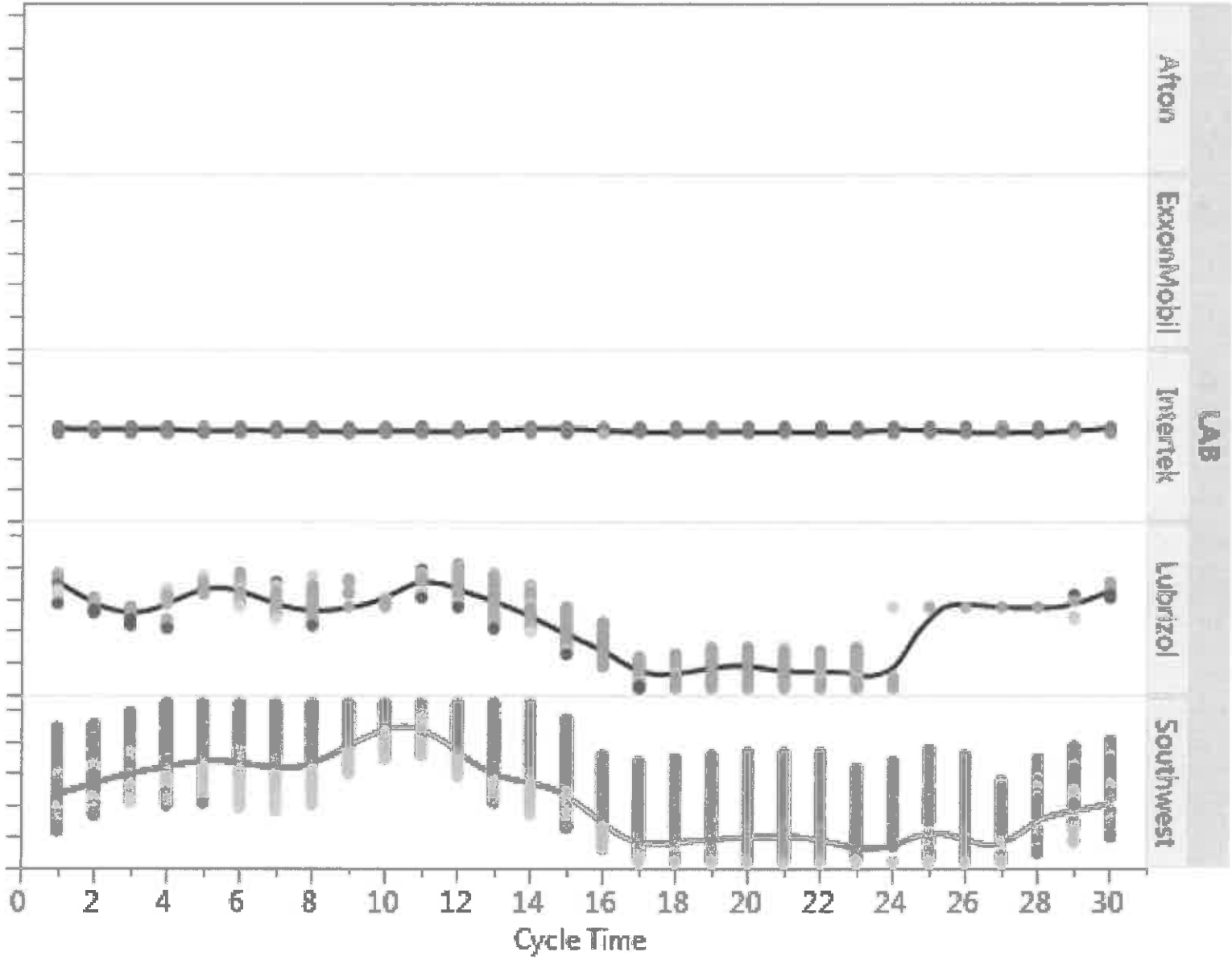


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Bank 1 STFT vs. Cycle Time

r = Hr101-102



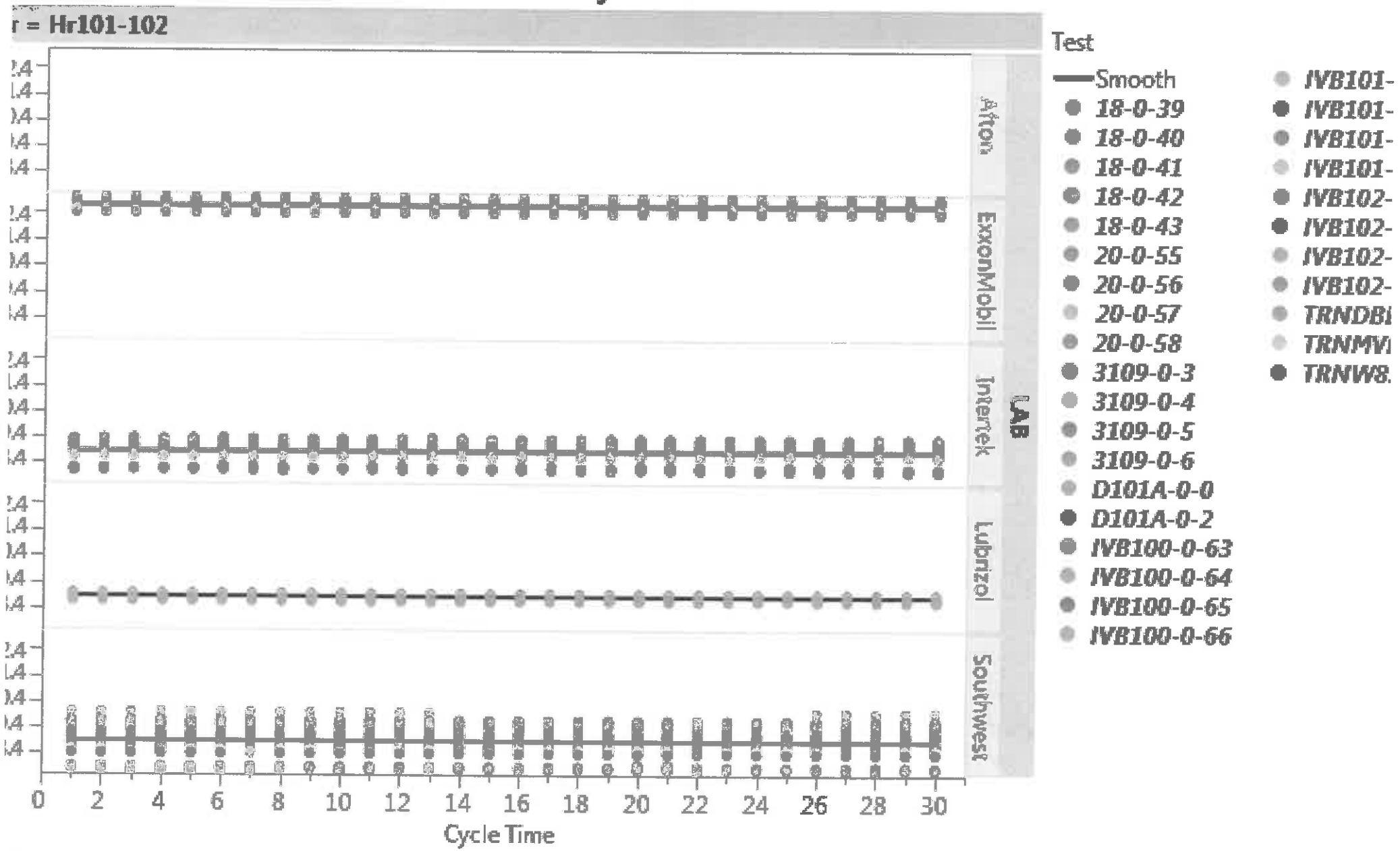
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

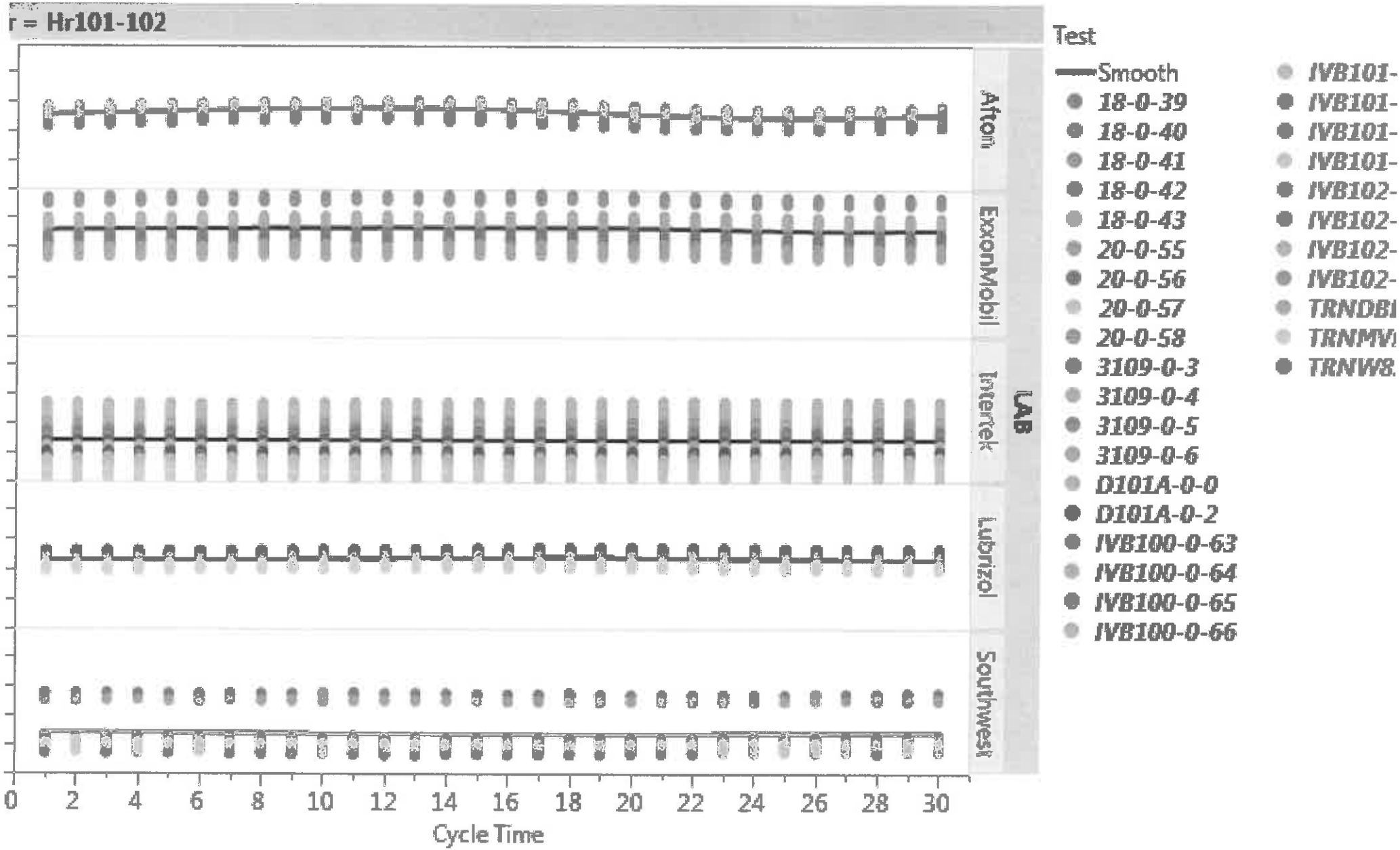
Barometric Pressure vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

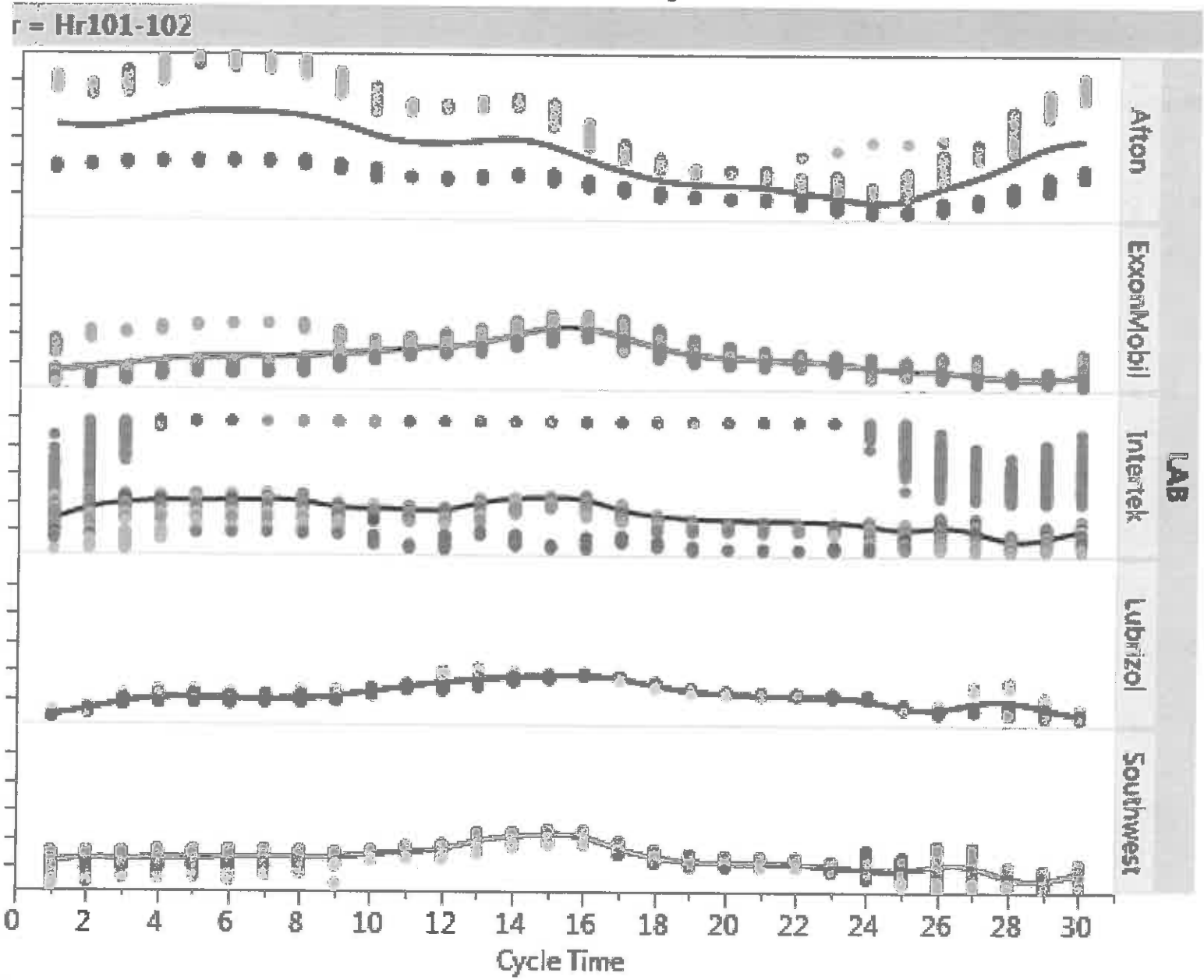
Blowby Coolant at Outlet vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Blowby Flow Rate vs. Cycle Time



Test

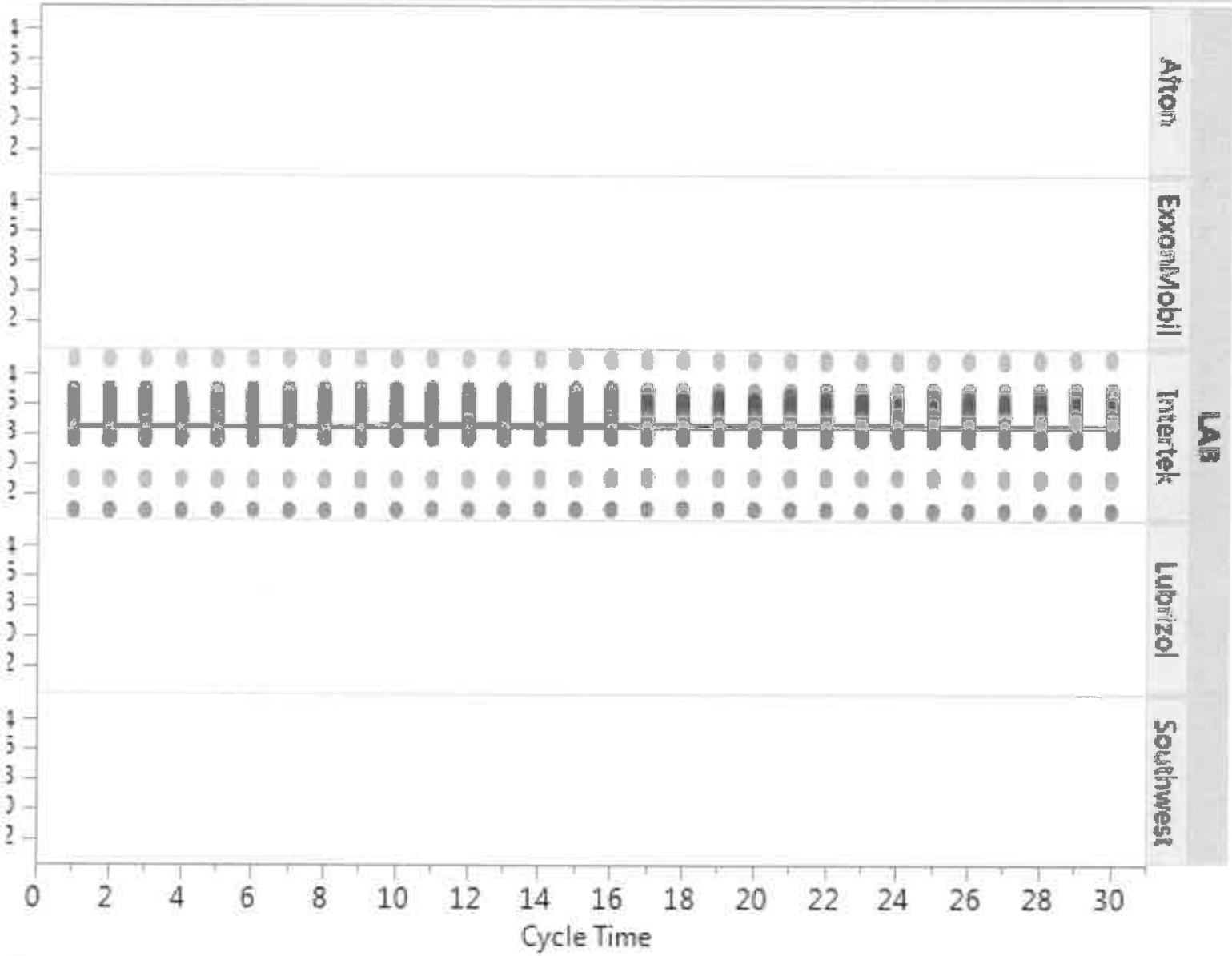
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Blowby Gas in Oil Separator (IAR Optional) vs. Cycle Time

r = Hr101-102



Test

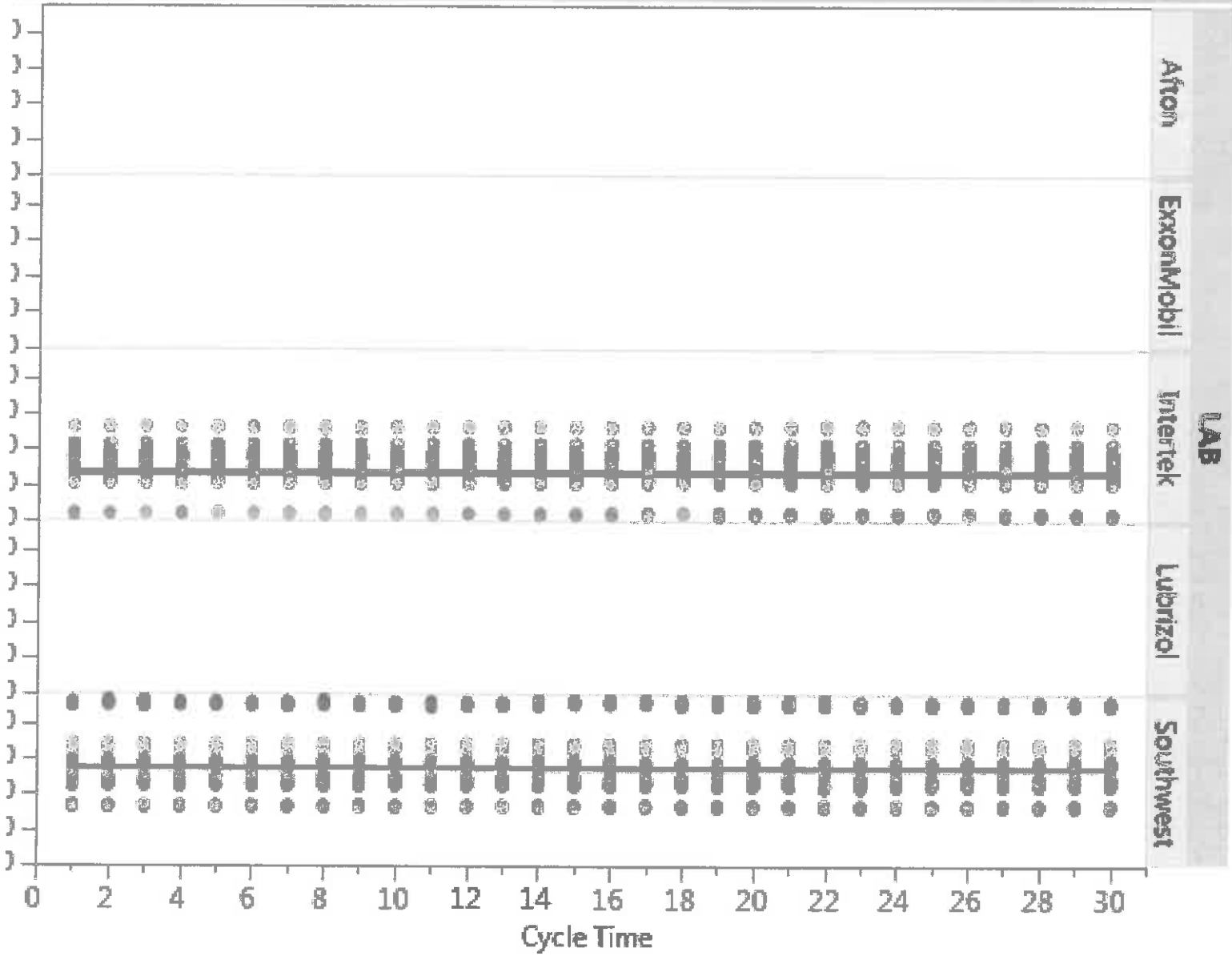
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Blowby Gas in Oil Separator (Optional) vs. Cycle Time

r = Hr101-102



Test

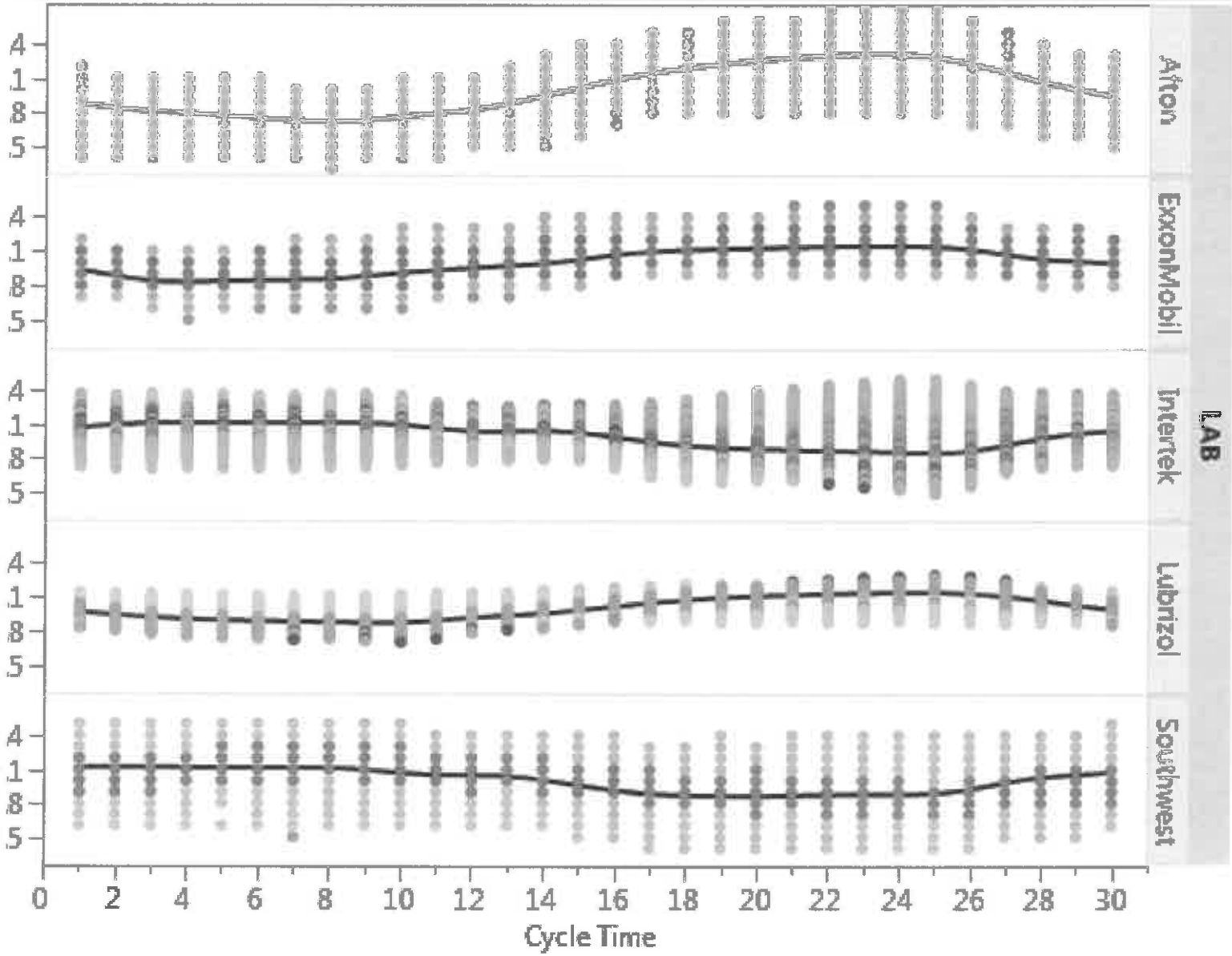
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Blowby Temperature (Controlled) vs. Cycle Time

r = Hr101-102



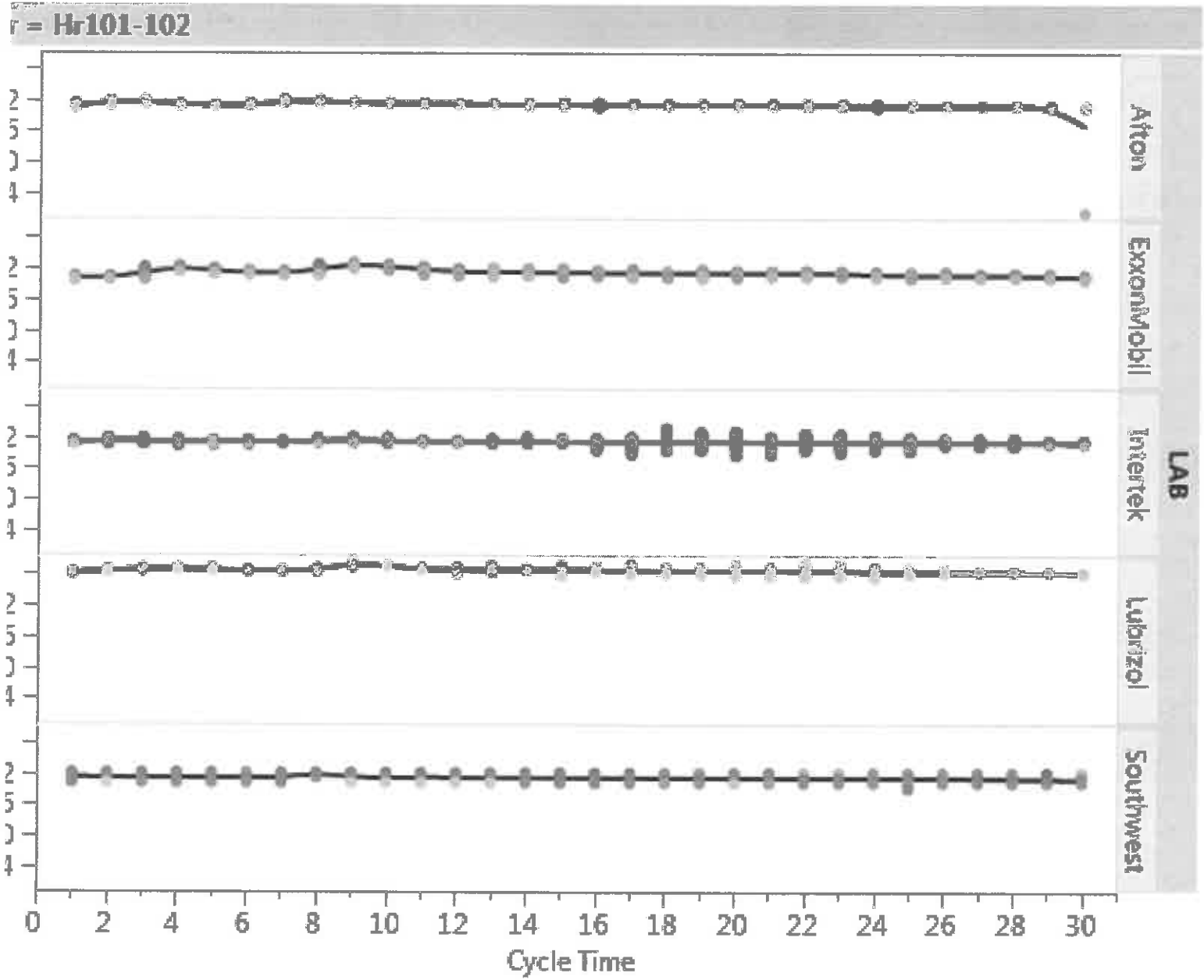
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Brake Mean Effective Pressure vs. Cycle Time



Test

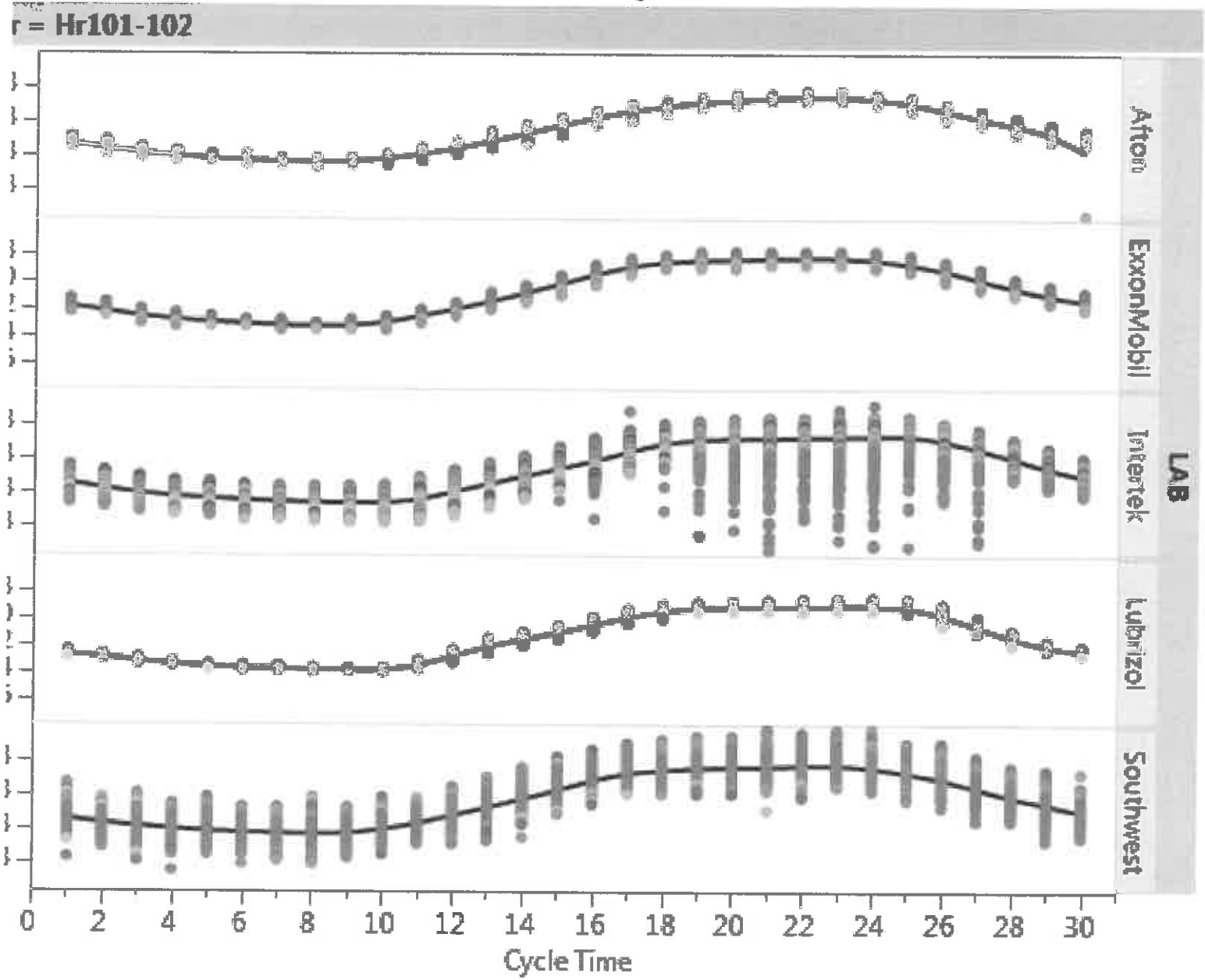
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMV
- TRNW8

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Delta vs. Cycle Time

r = Hr101-102



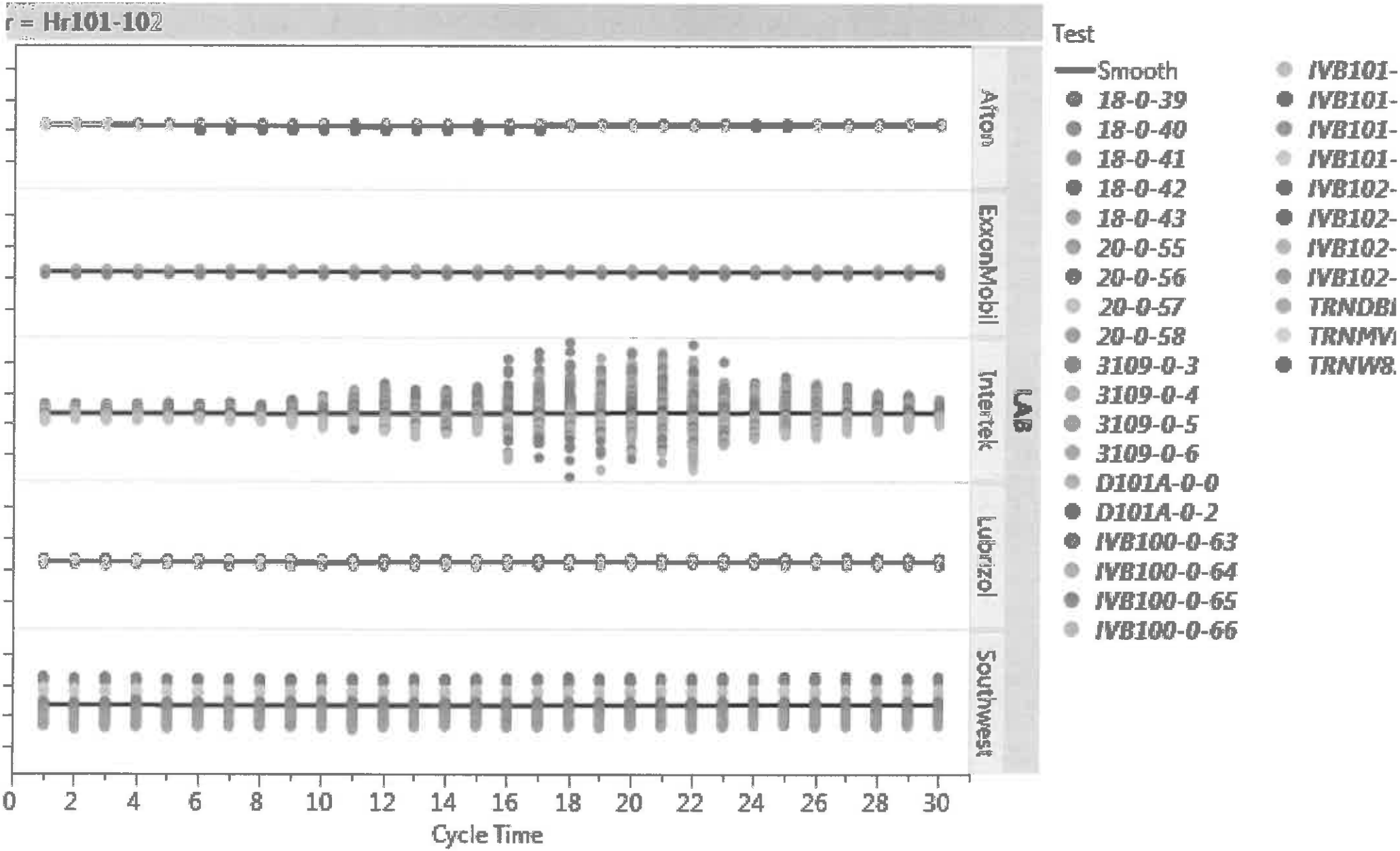
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Inlet Pressure vs. Cycle Time

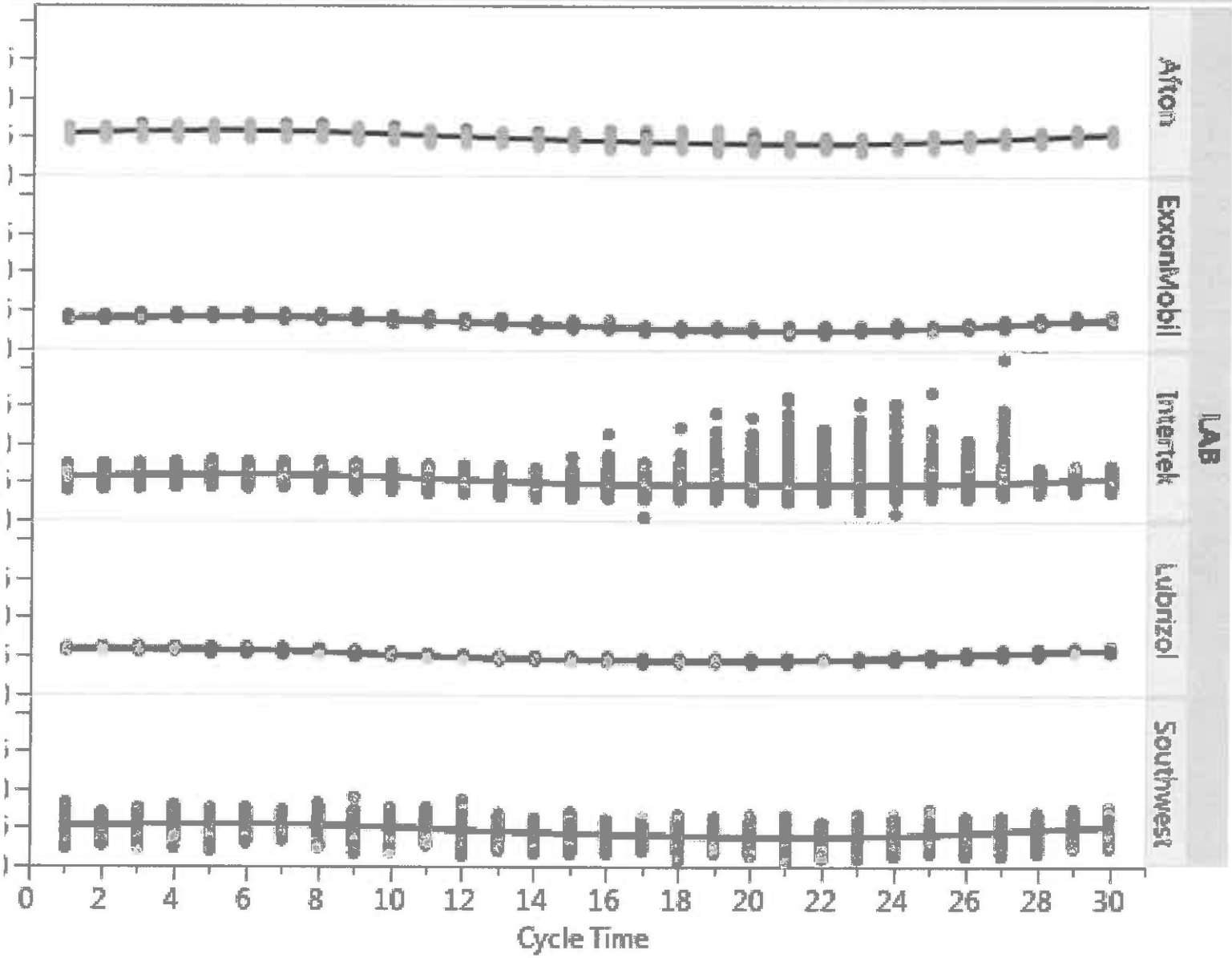


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Temperature Into Engine vs. Cycle Time

r = Hr101-102



Test

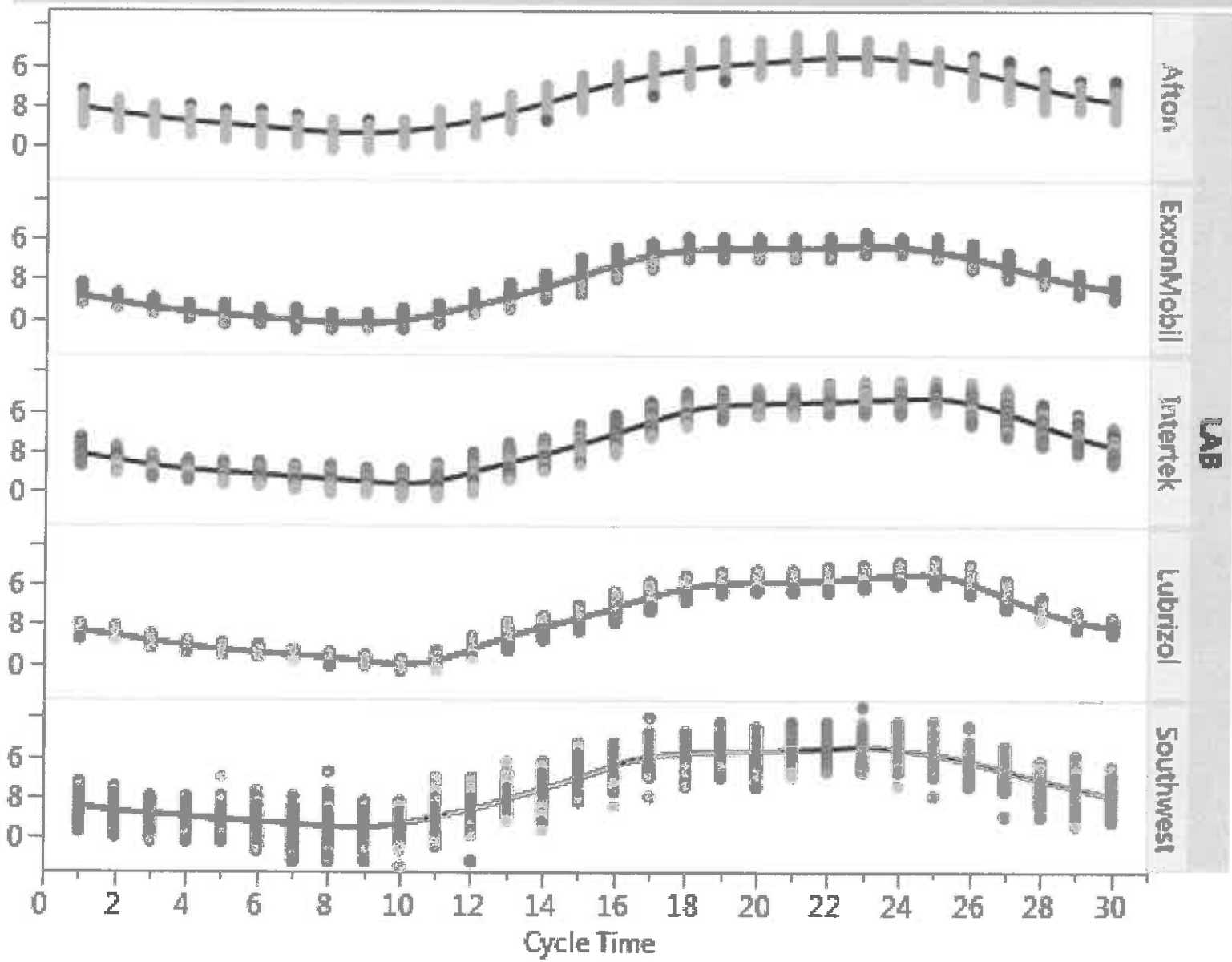
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Temperature Out of Engine vs. Cycle Time

r = Hr101-102



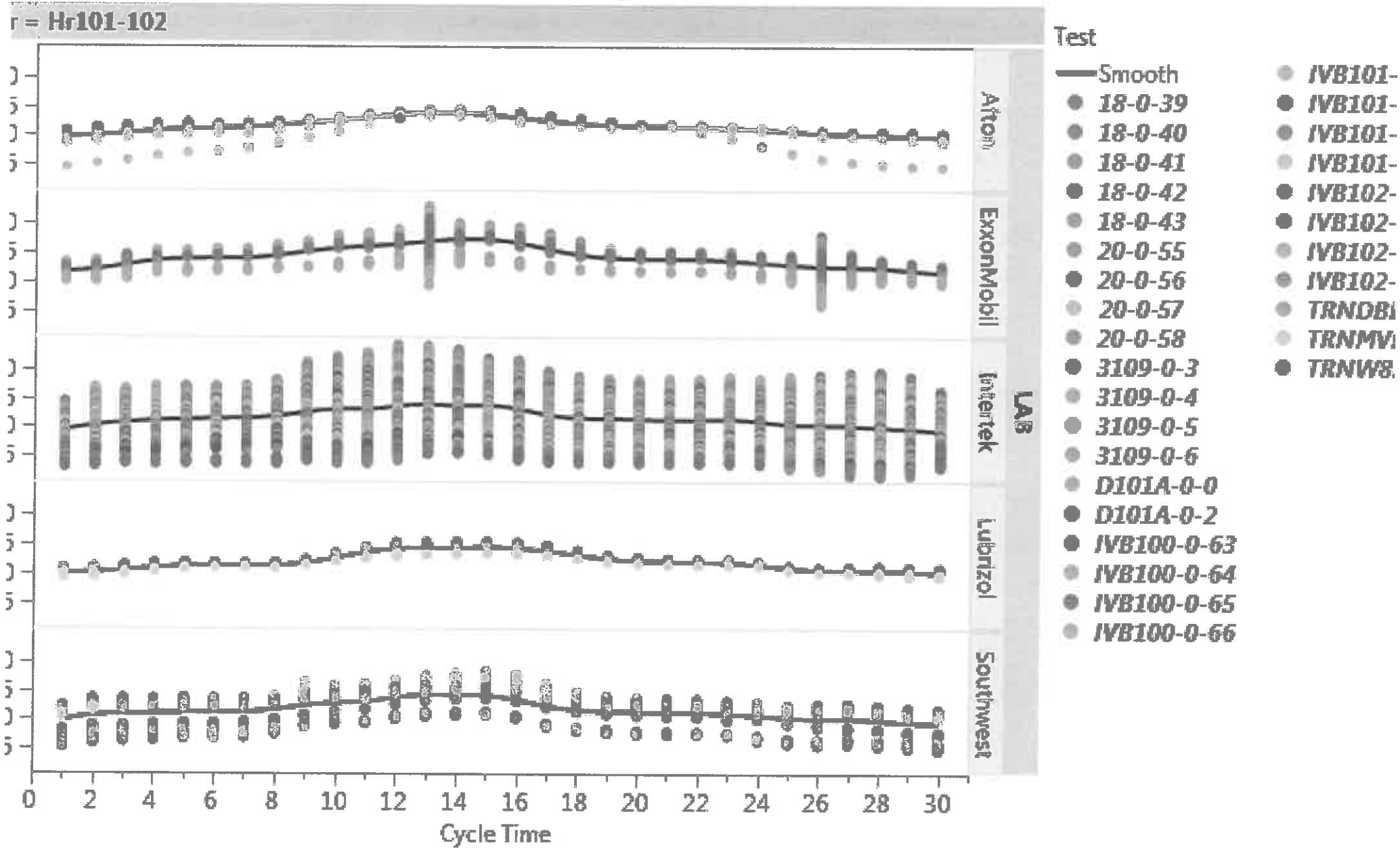
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Crankcase Gas Pressure vs. Cycle Time

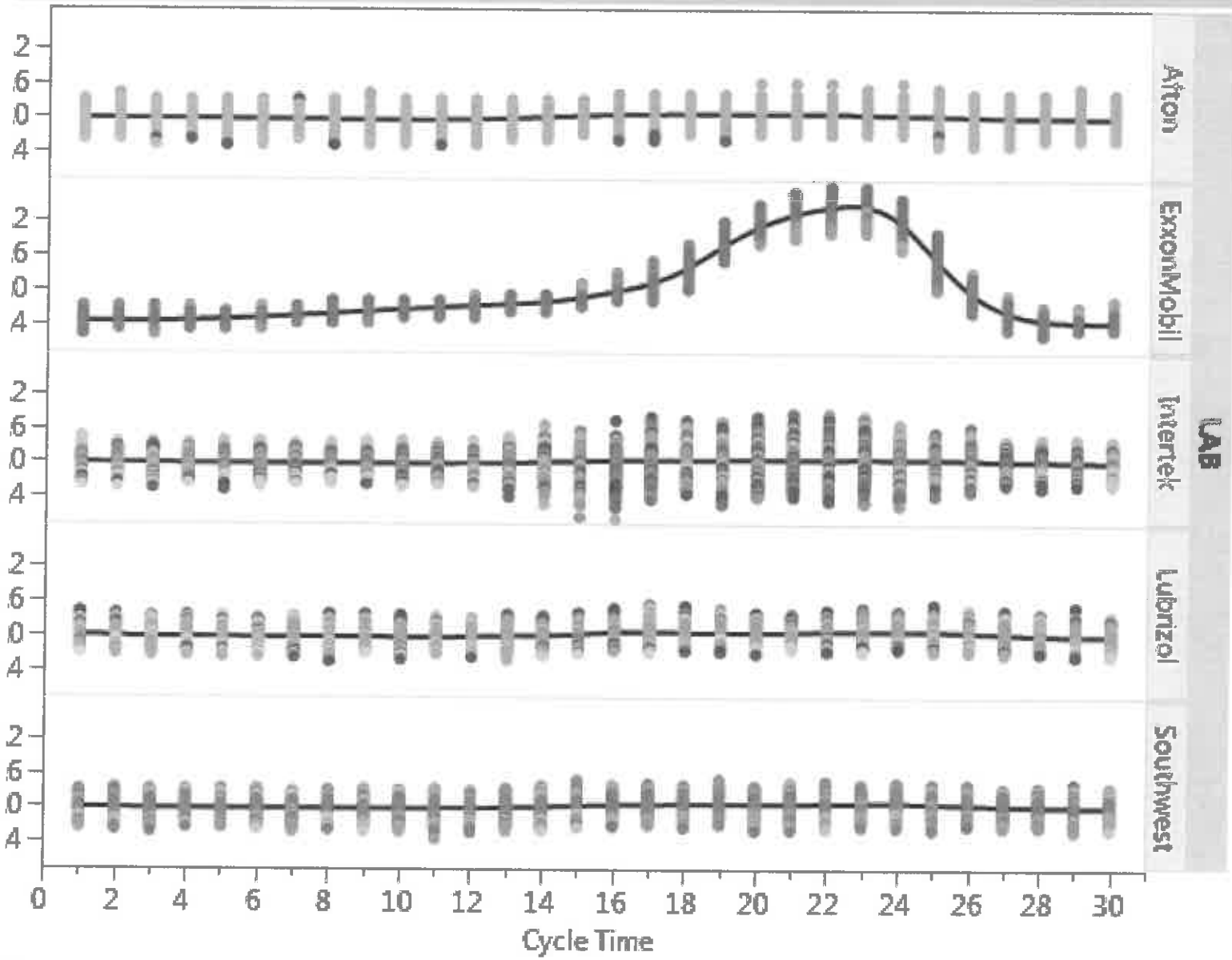


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest)}

h Builder

Engine Coolant Flow Rate vs. Cycle Time

r = Hr101-102



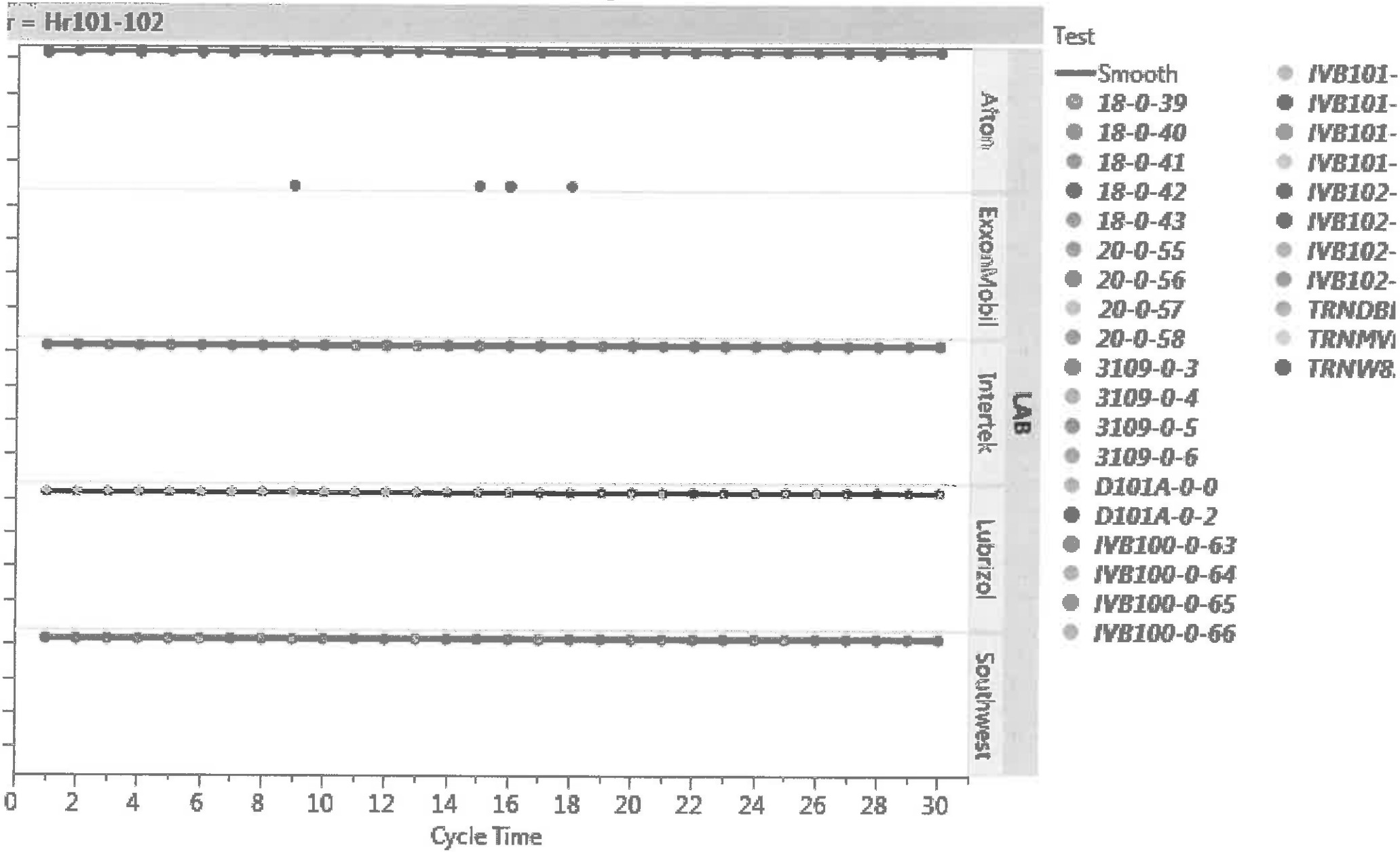
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

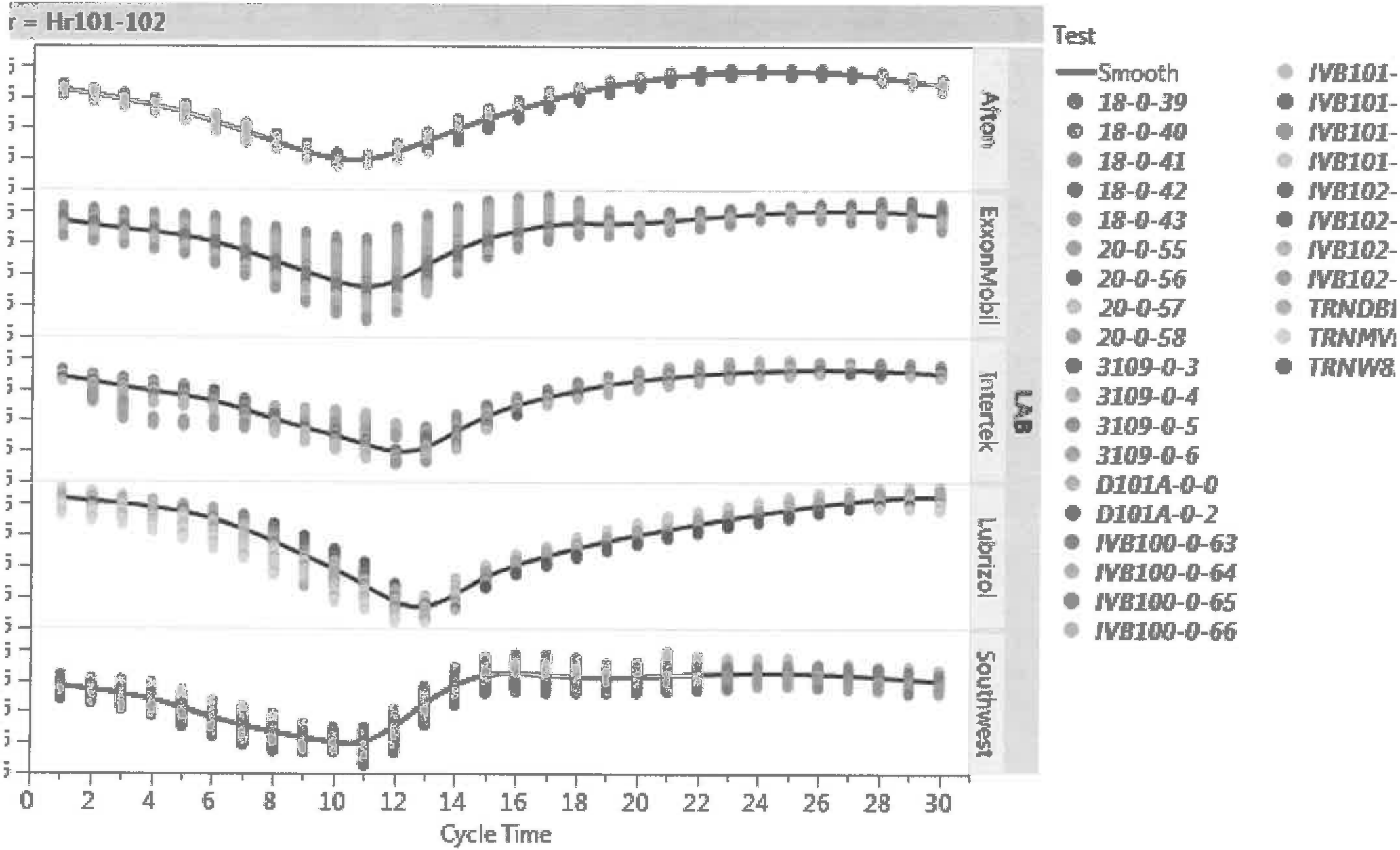
Engine Coolant Temp. vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Oil Gallery (Temp.) vs. Cycle Time

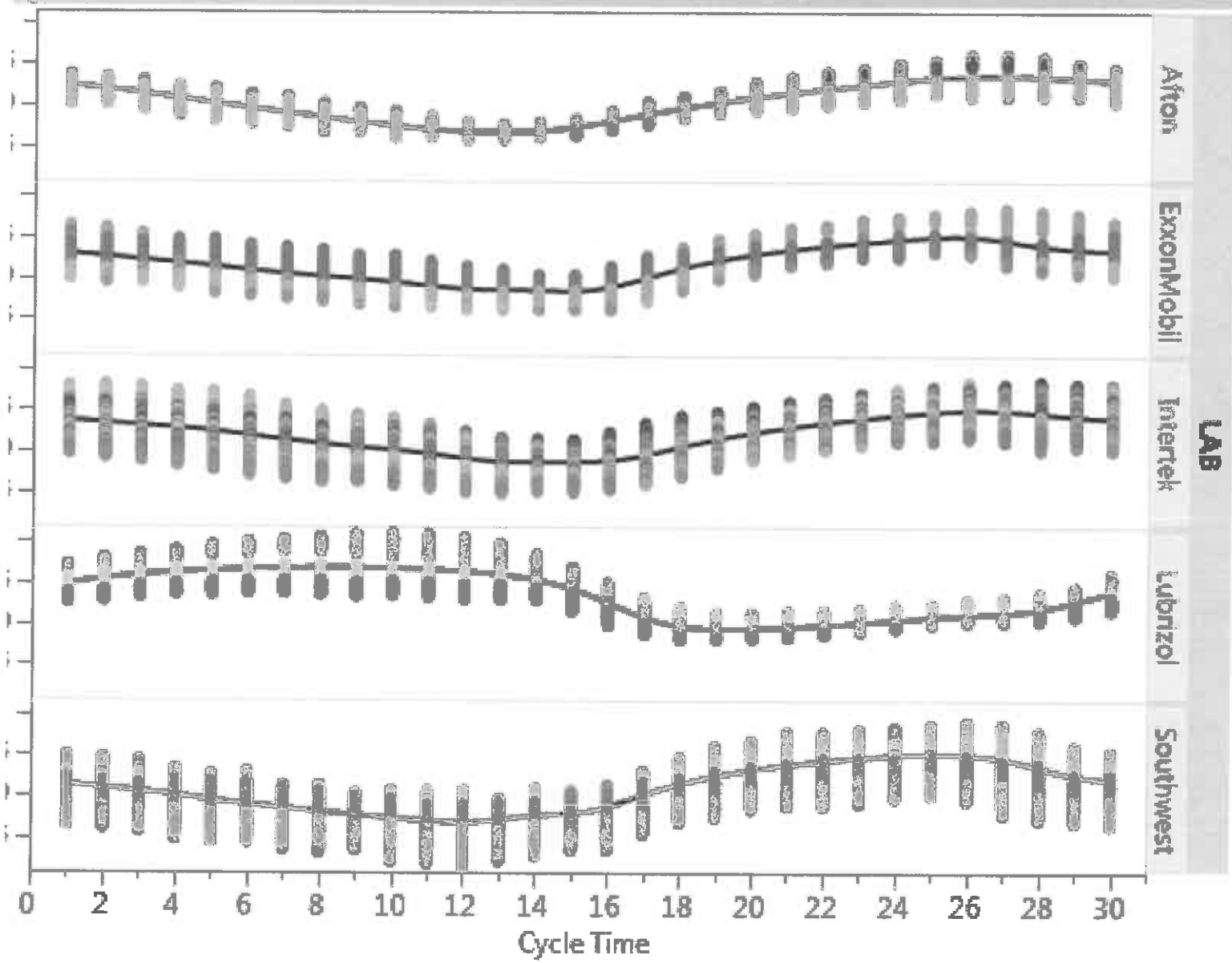


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Oil Sump (Temp.) vs. Cycle Time

r = Hr101-102



Test

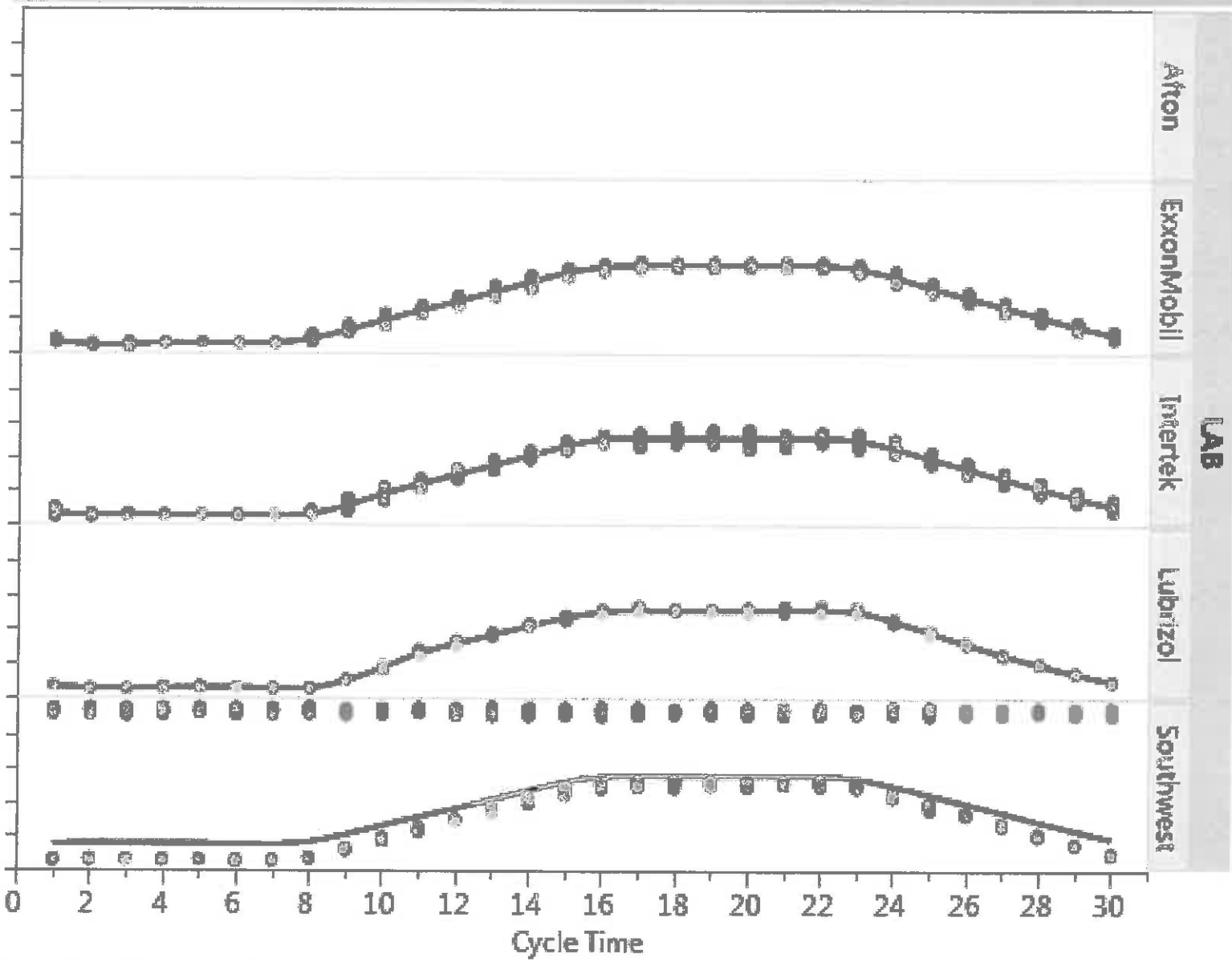
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Power vs. Cycle Time

r = Hr101-102



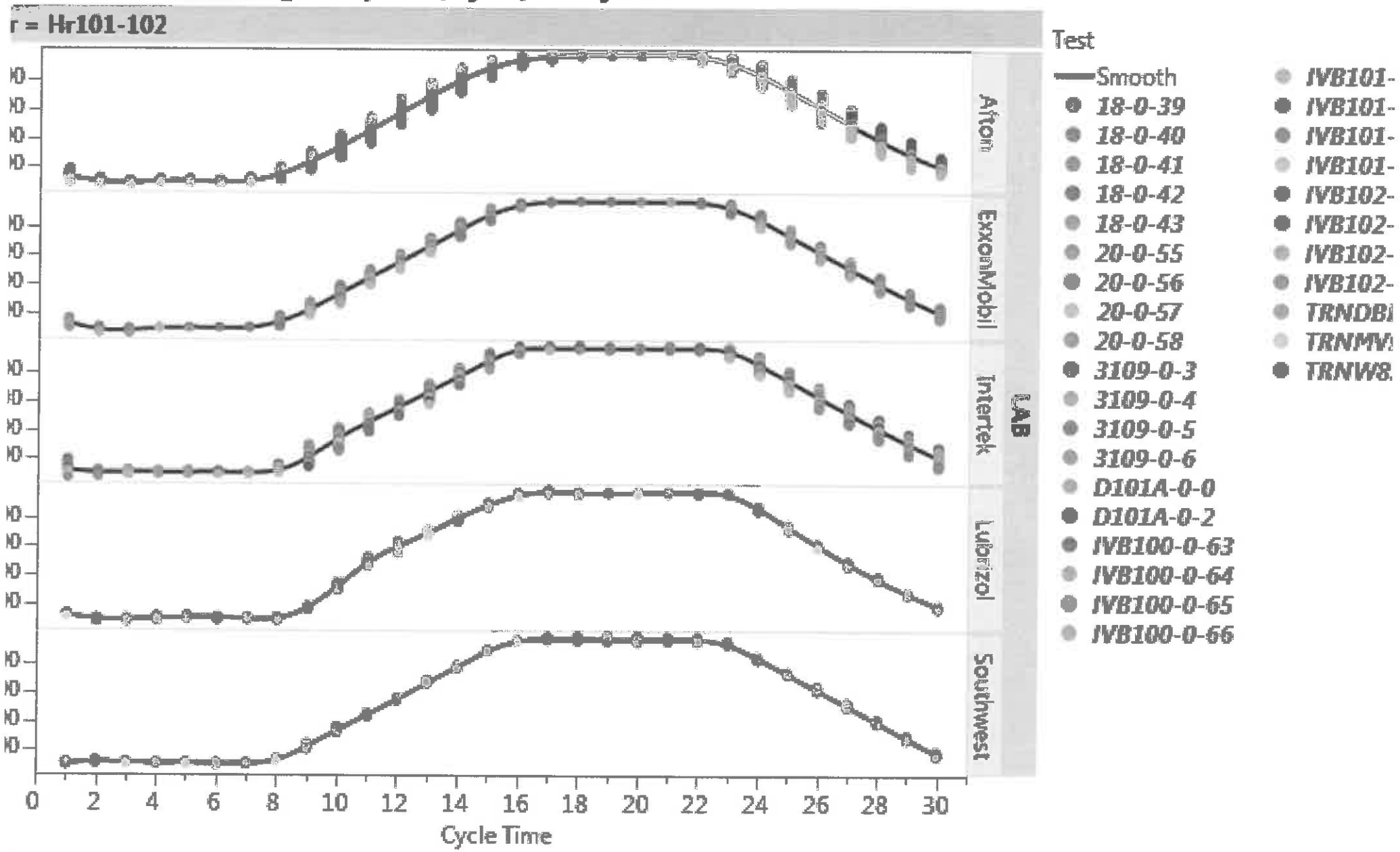
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

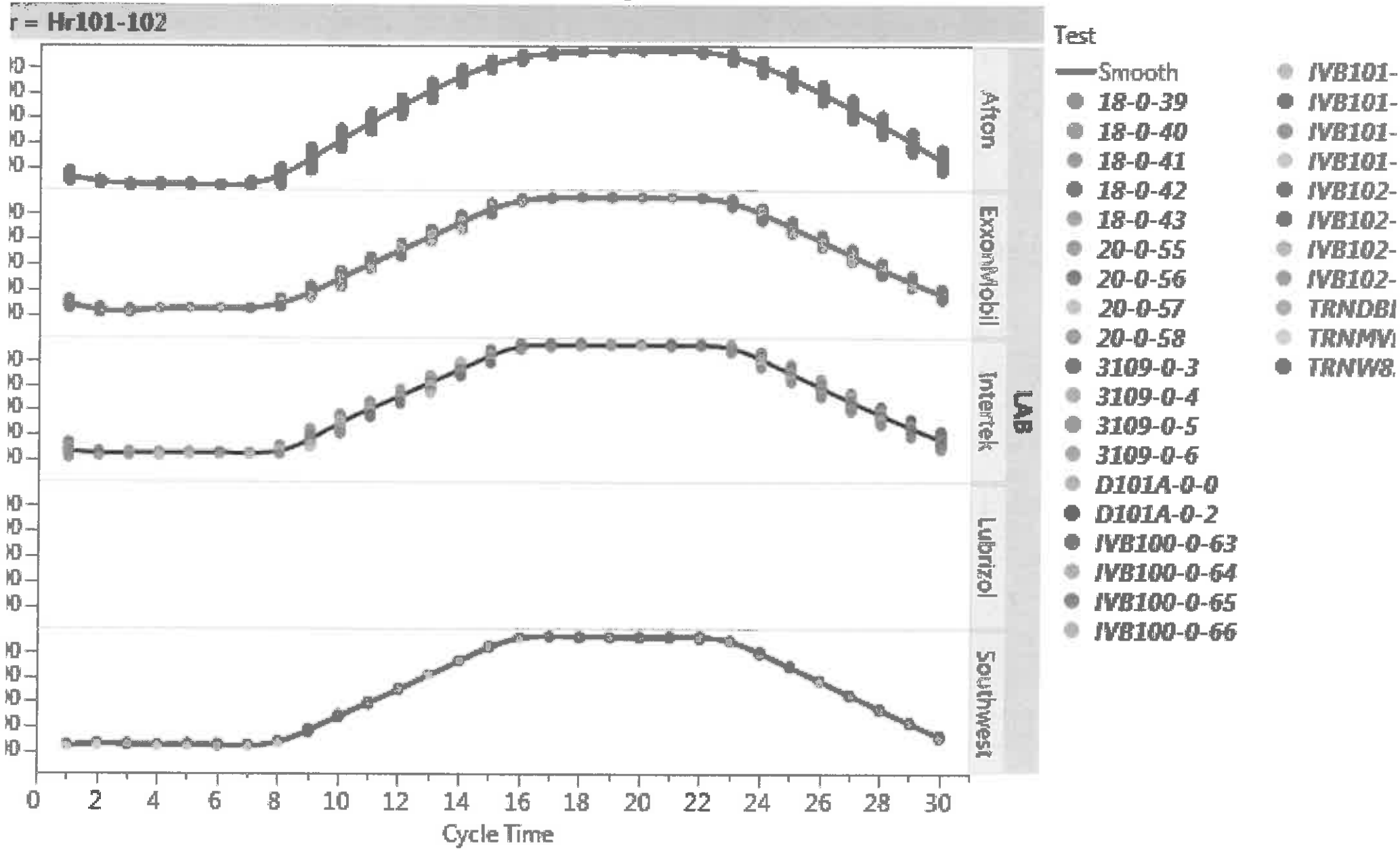
Engine Speed (Dyno) vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Speed (Flywheel) vs. Cycle Time

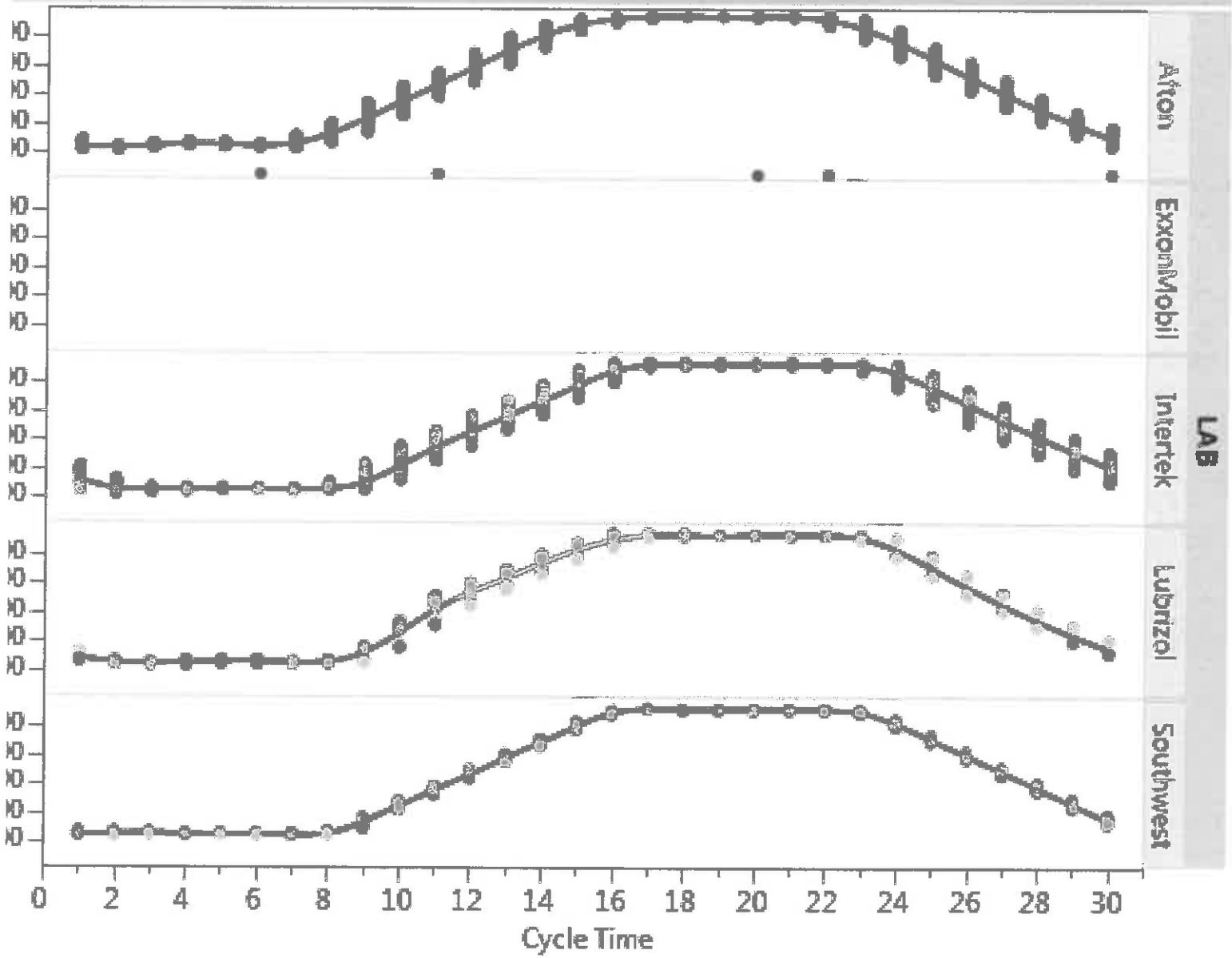


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Speed vs. Cycle Time

r = Hr101-102



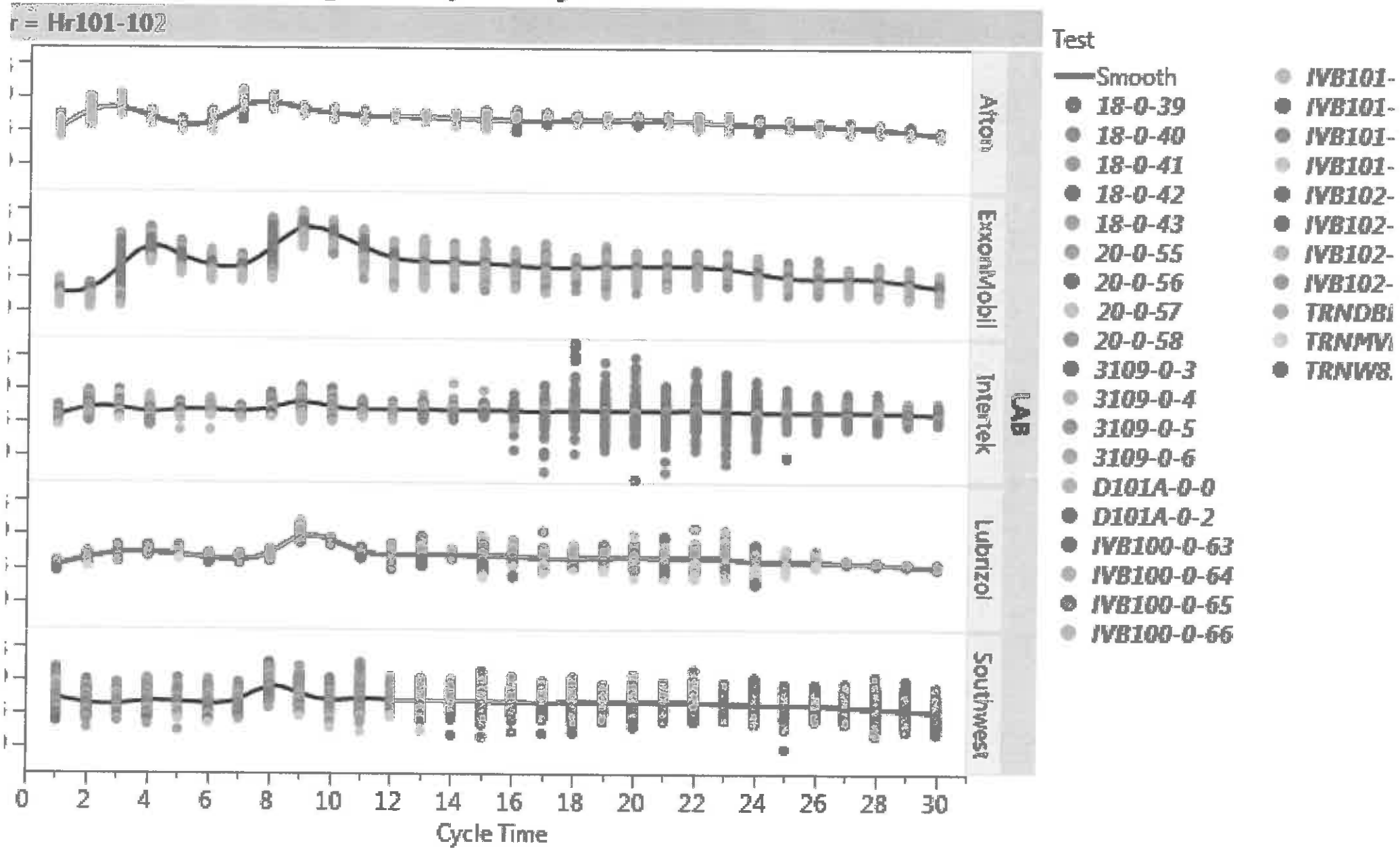
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMV
- TRNW8

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

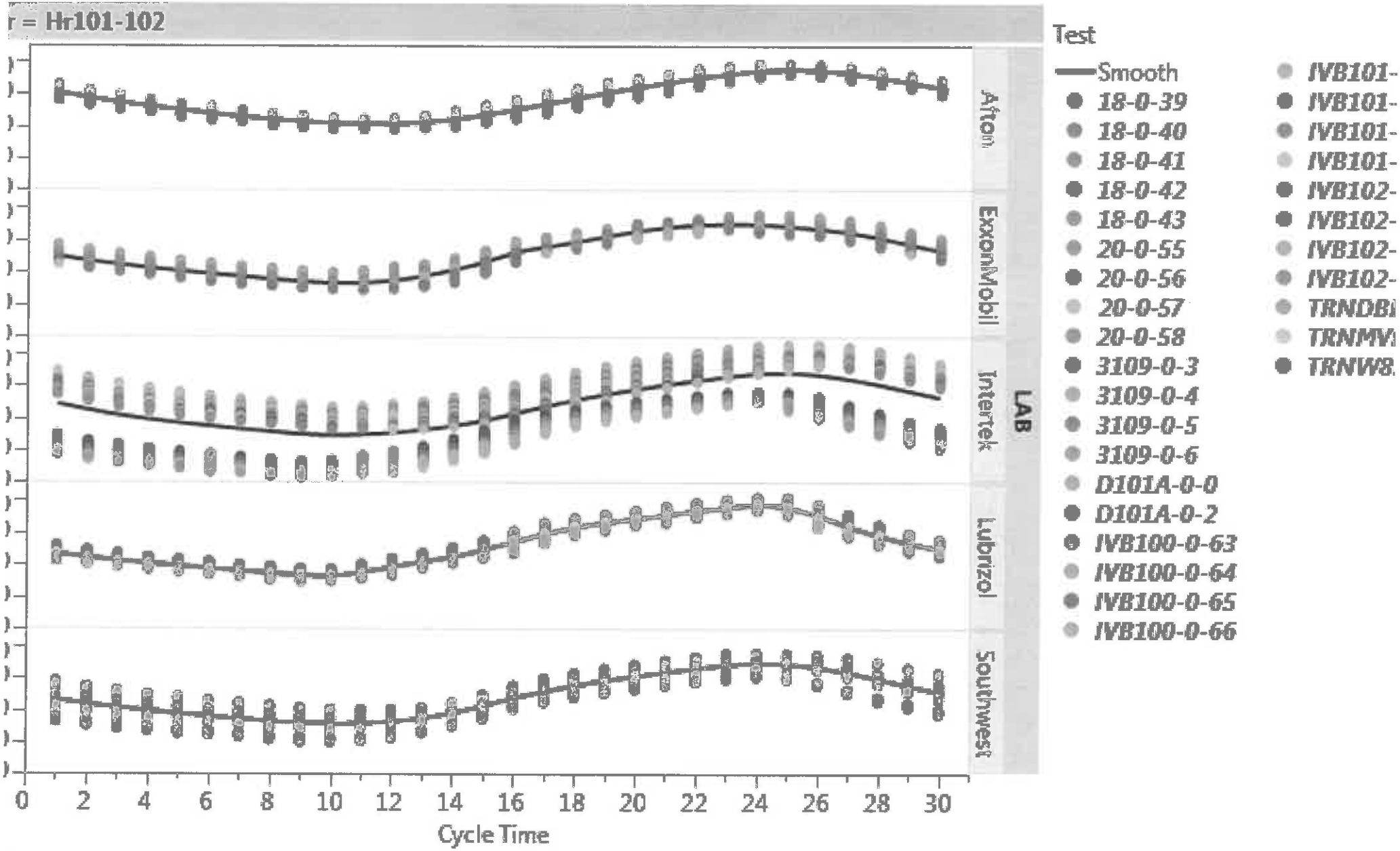
Engine Torque vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Exhaust Gas Temperature vs. Cycle Time

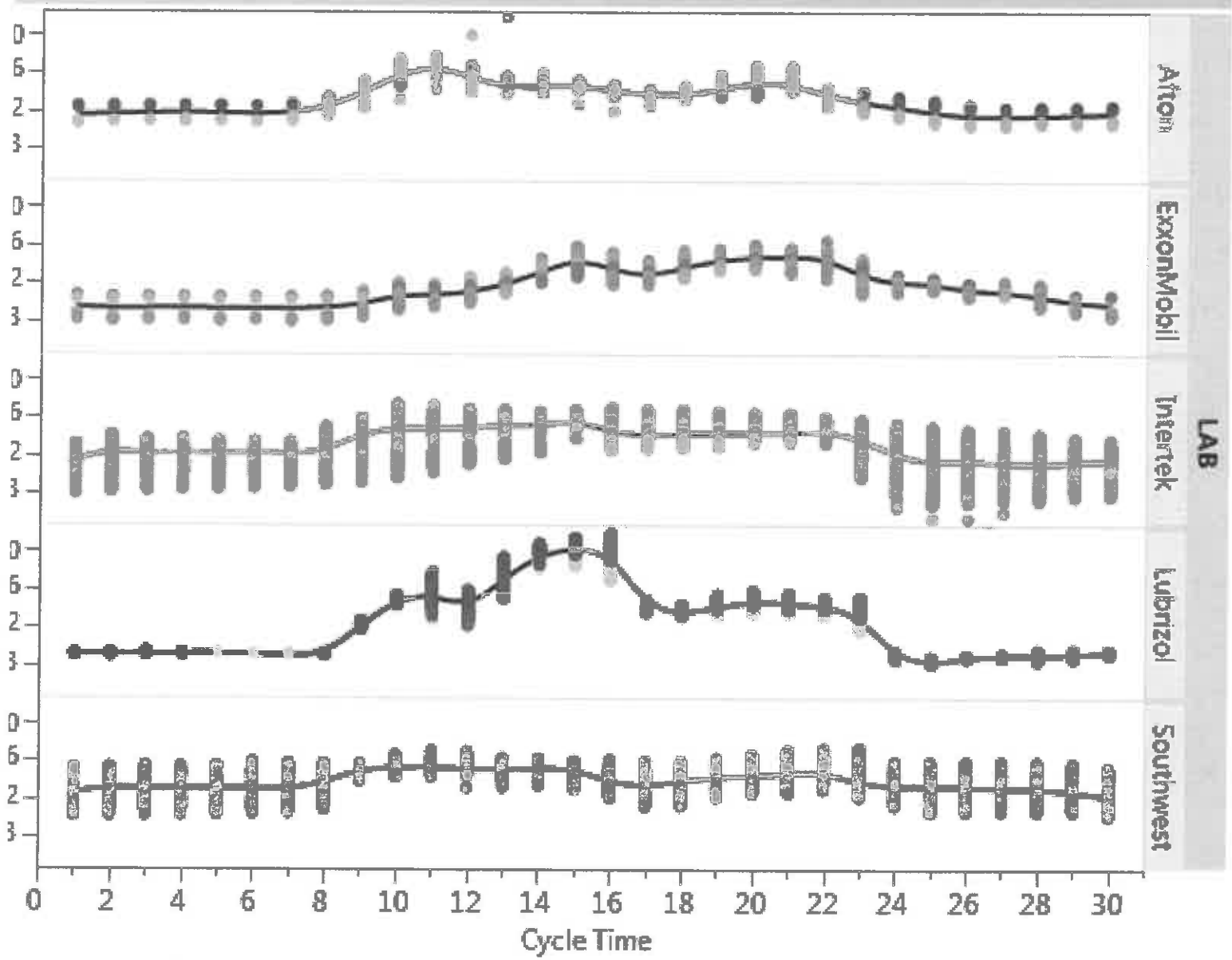


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Exhaust Pressure vs. Cycle Time

r = Hr101-102



Test

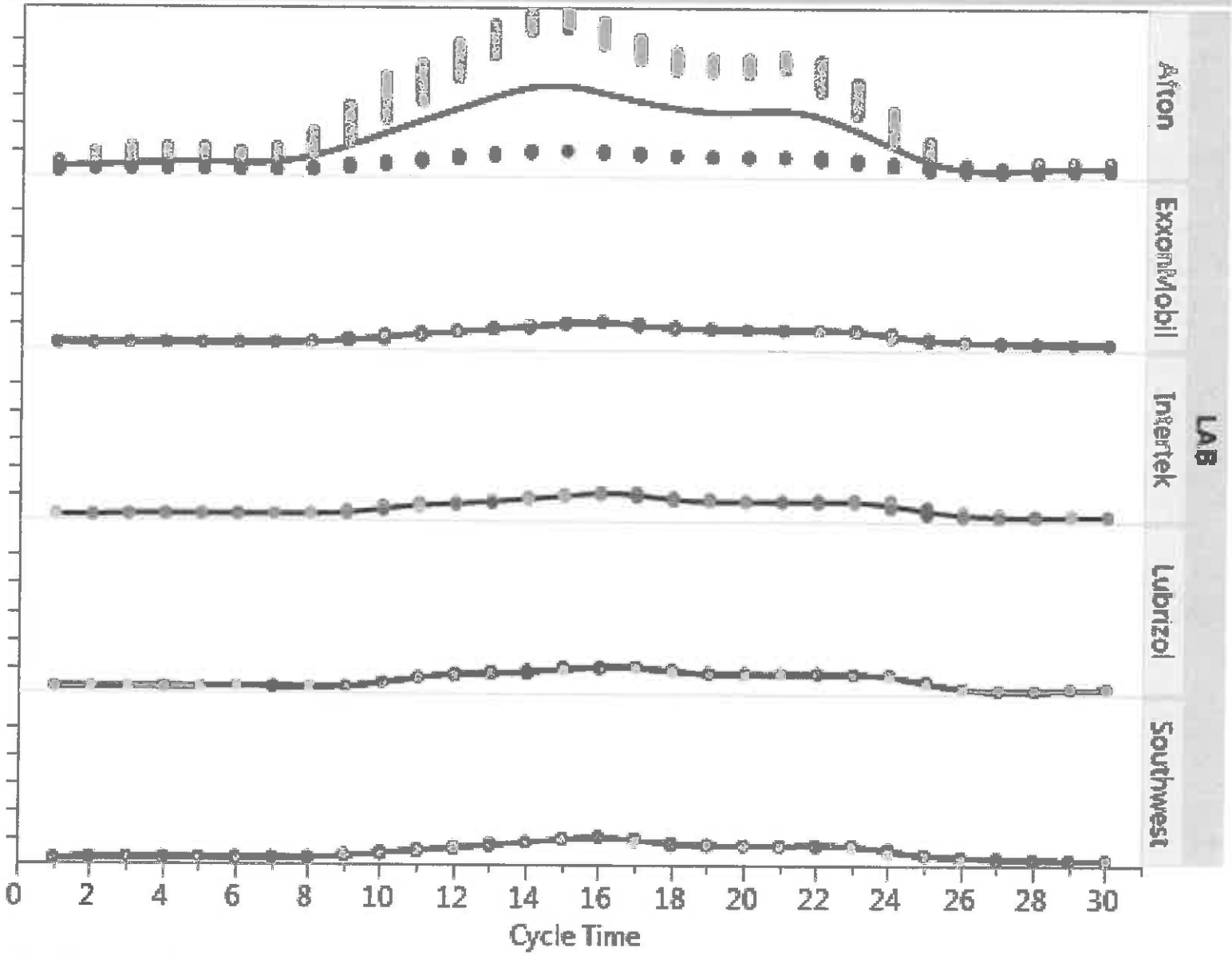
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMV
- TRNW8

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Fuel Flow Rate vs. Cycle Time

r = Hr101-102



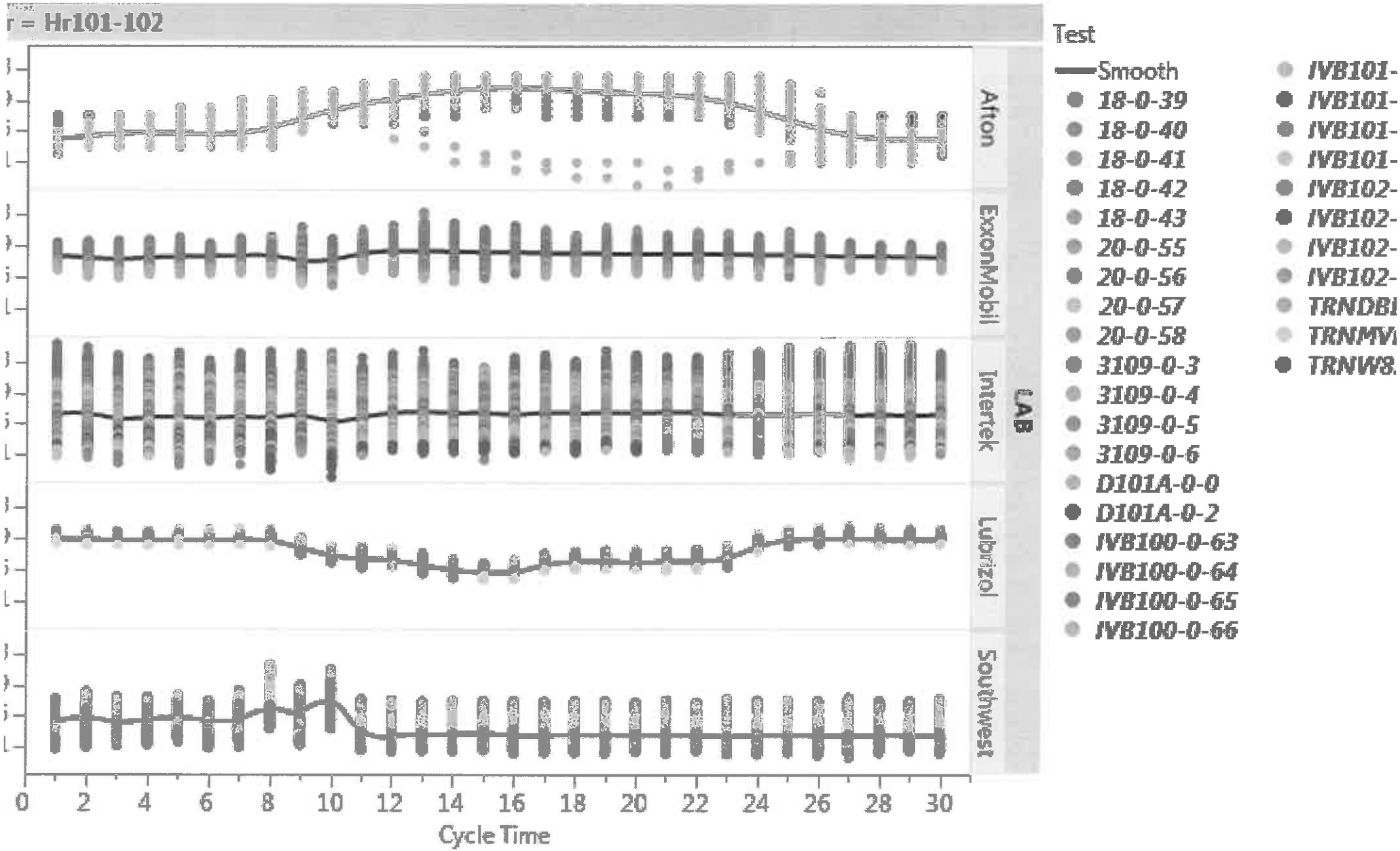
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMV
- TRNW8

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

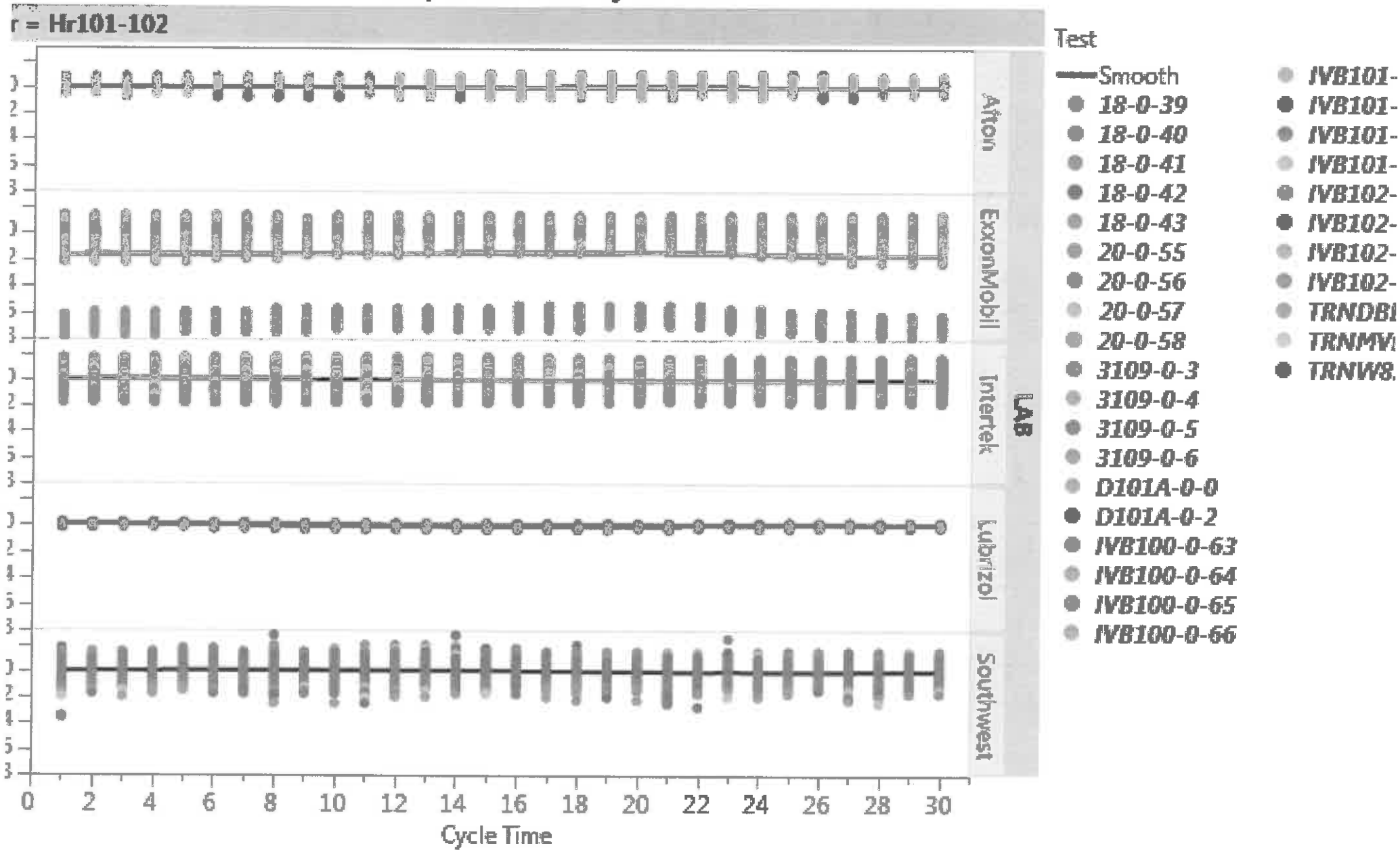
Fuel Rail Pressure vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

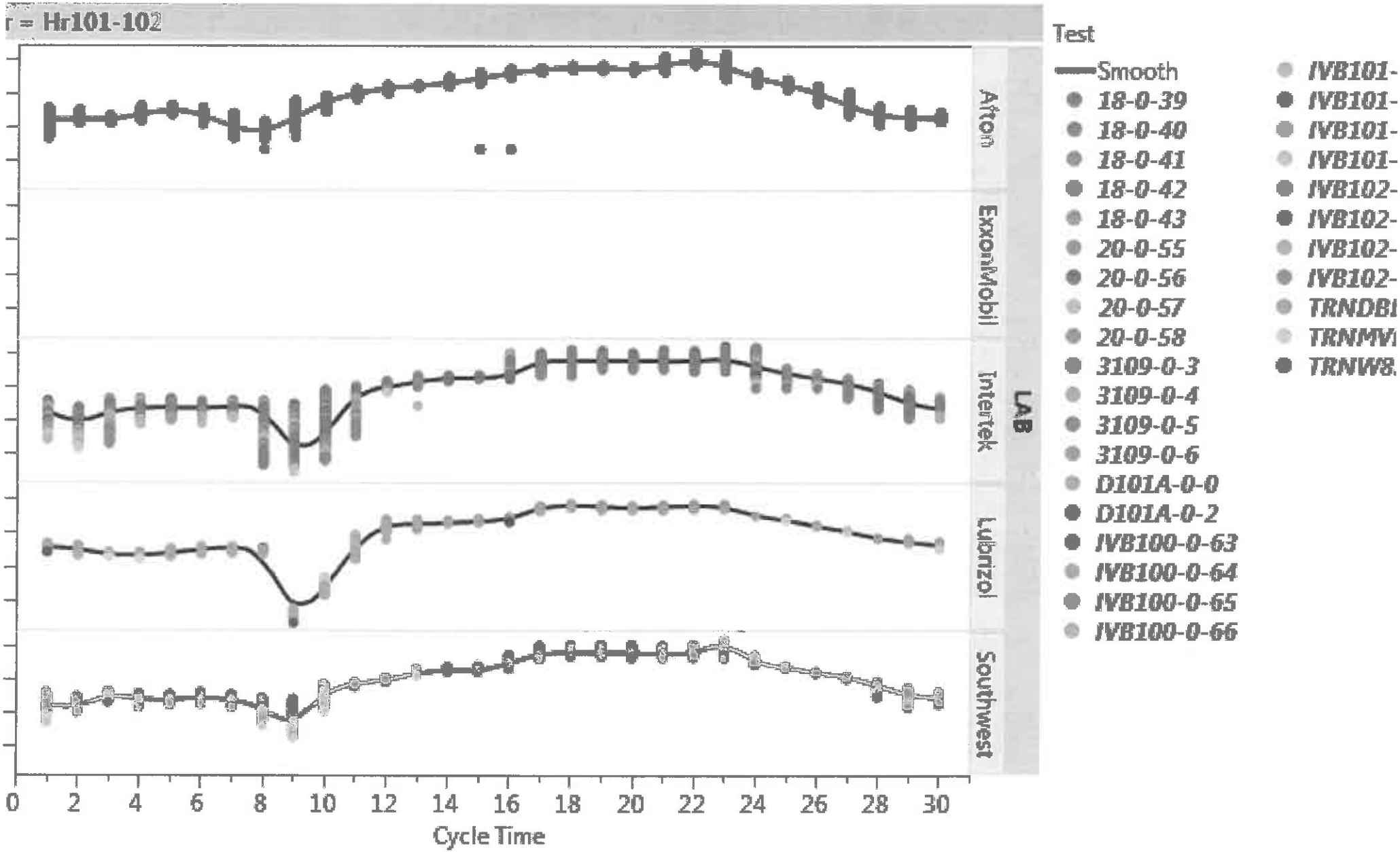
Fuel Rail Temperature vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

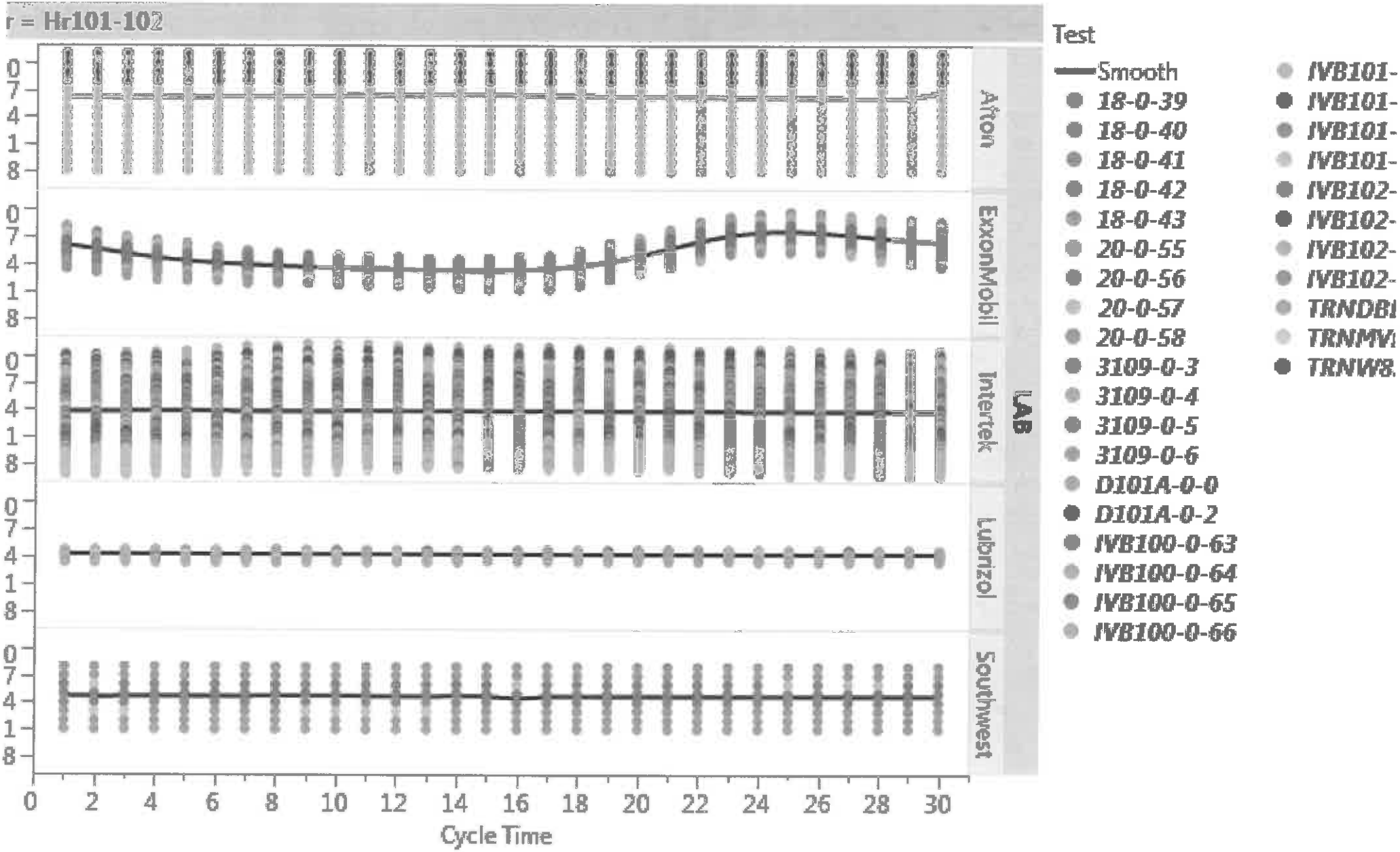
Ignition Timing Advance vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Air Humidity vs. Cycle Time

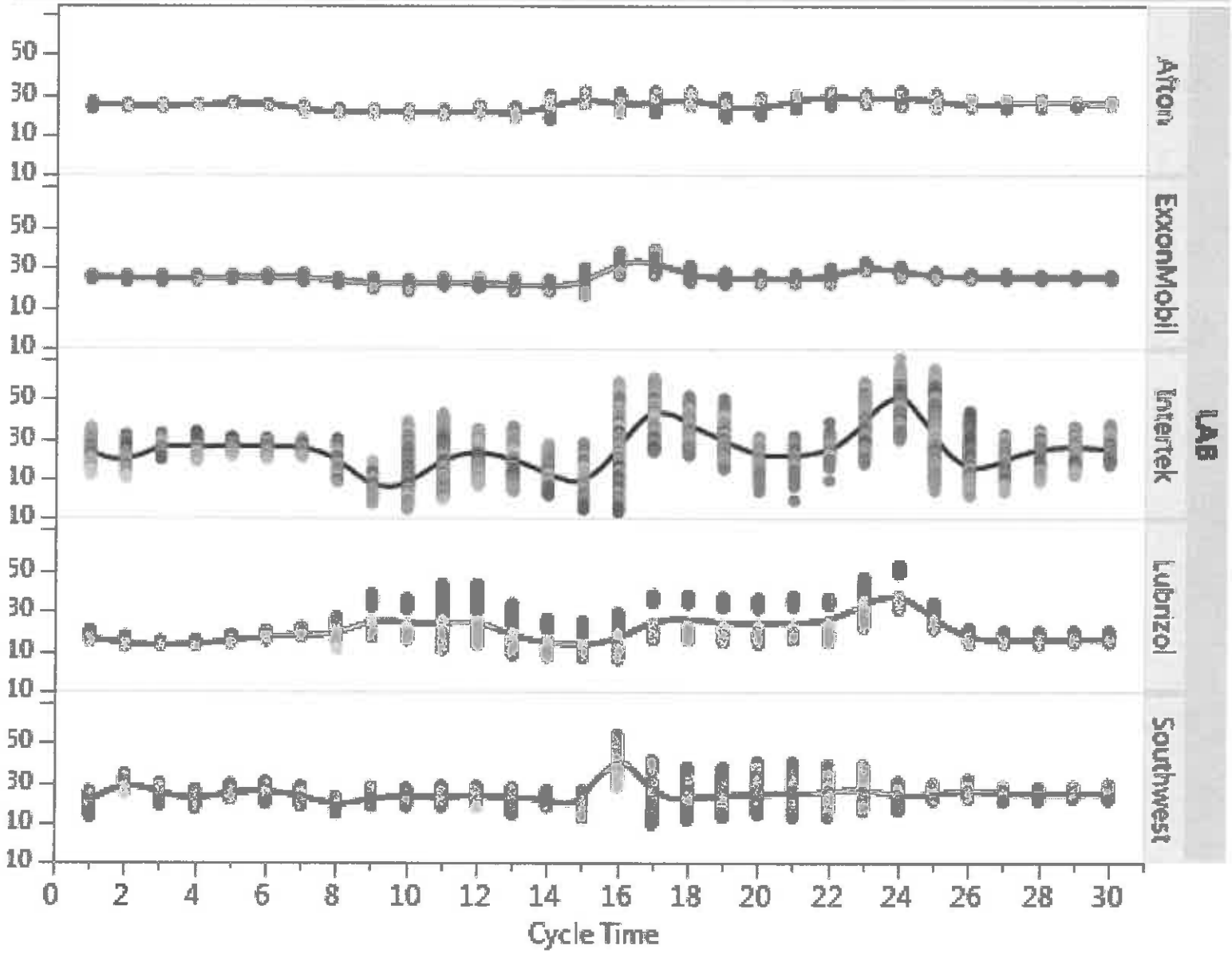


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Air Presure vs. Cycle Time

r = Hr101-102



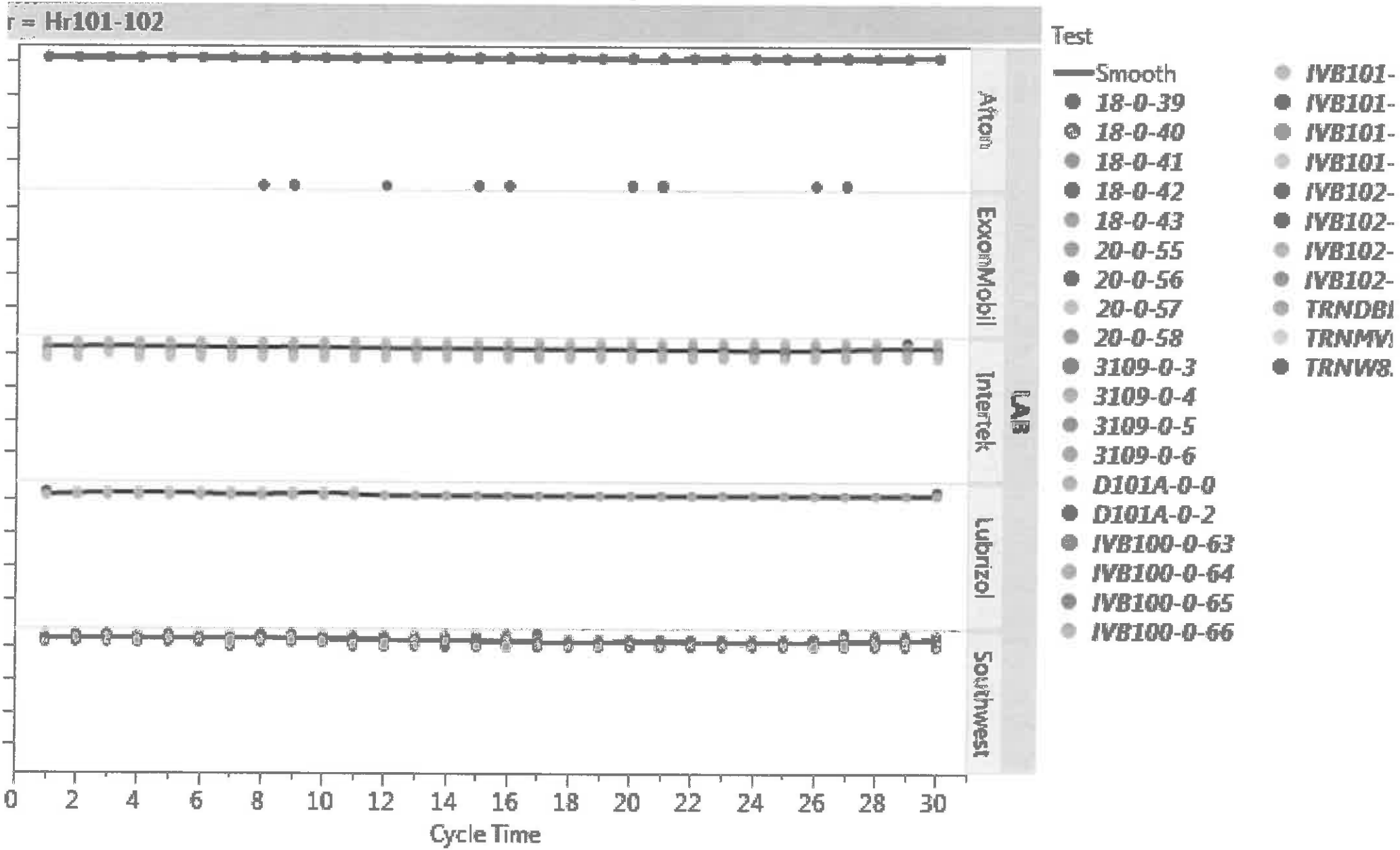
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Air Temperature 2 vs. Cycle Time

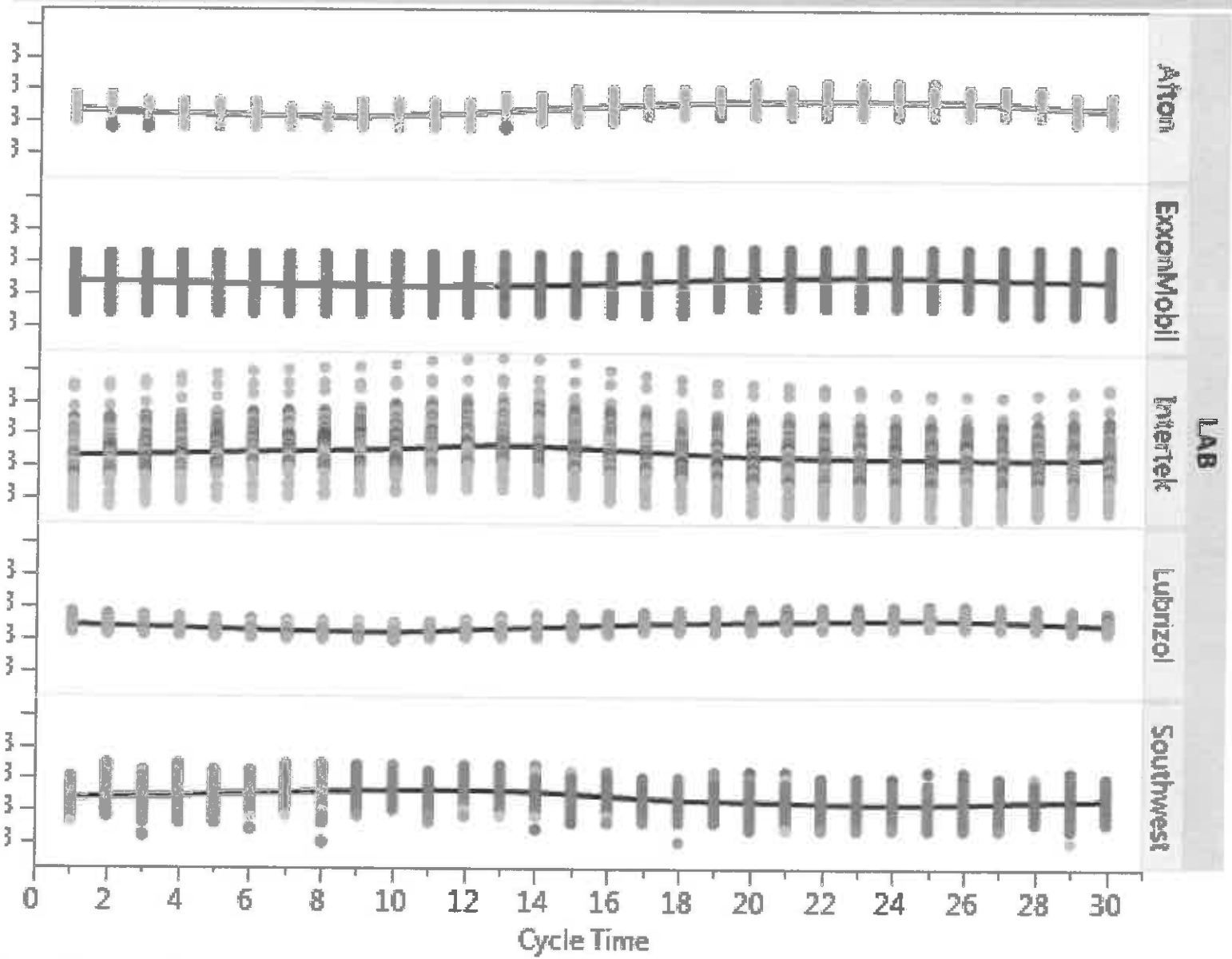


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Air Temperature vs. Cycle Time

r = Hr101-102



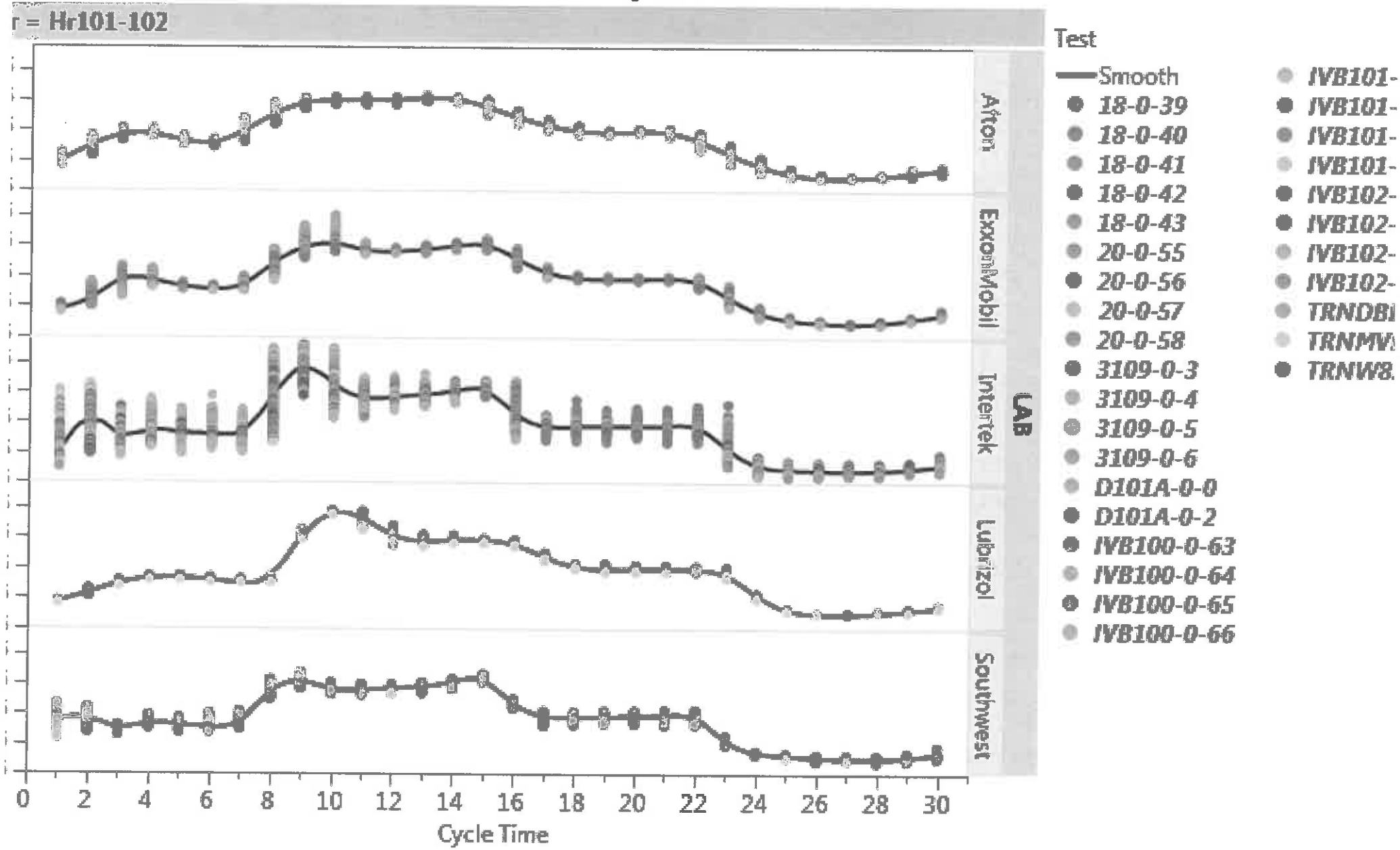
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

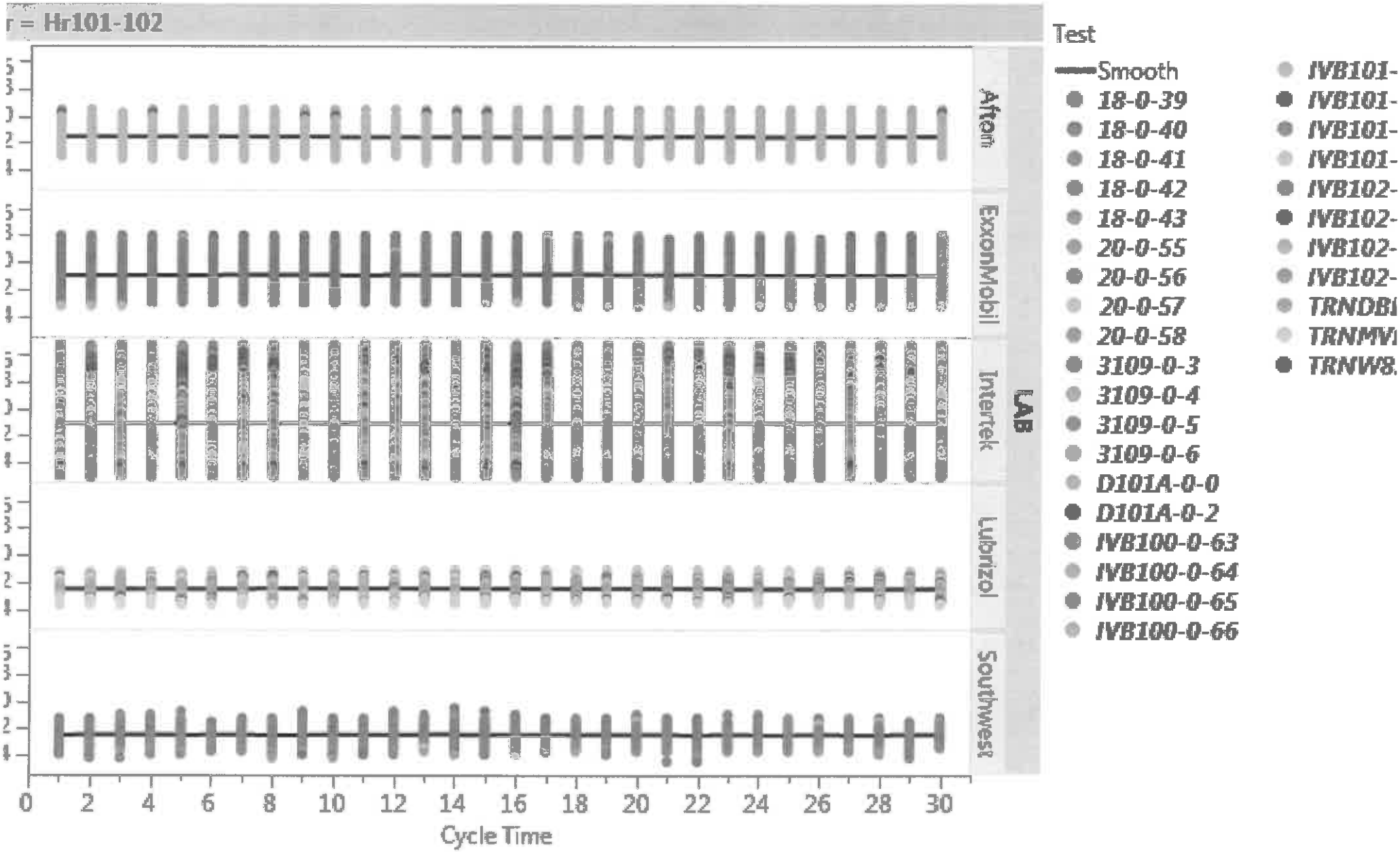
Intake Manifold Pressure vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Load Cell Temperature vs. Cycle Time

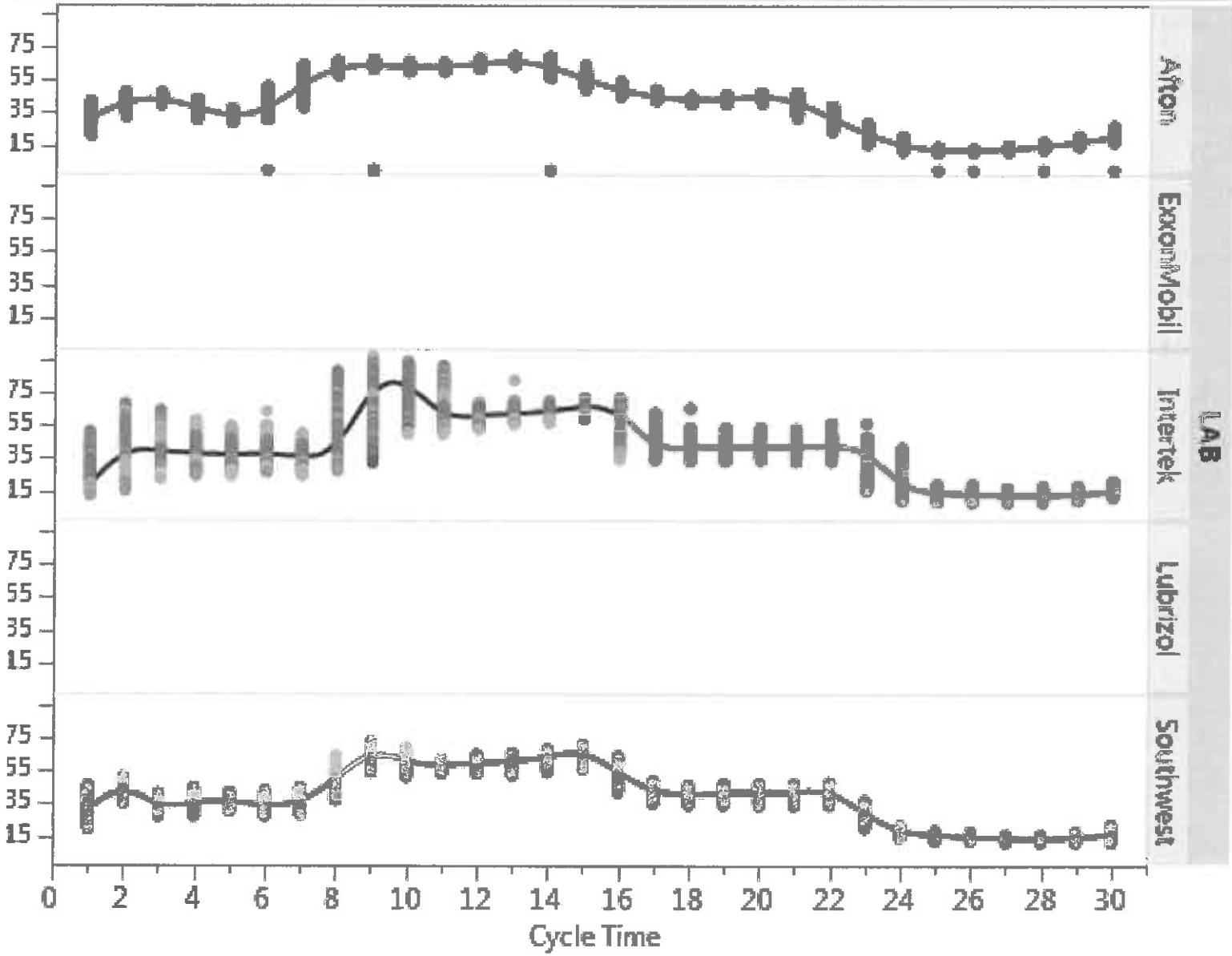


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

MAP vs. Cycle Time

r = Hr101-102



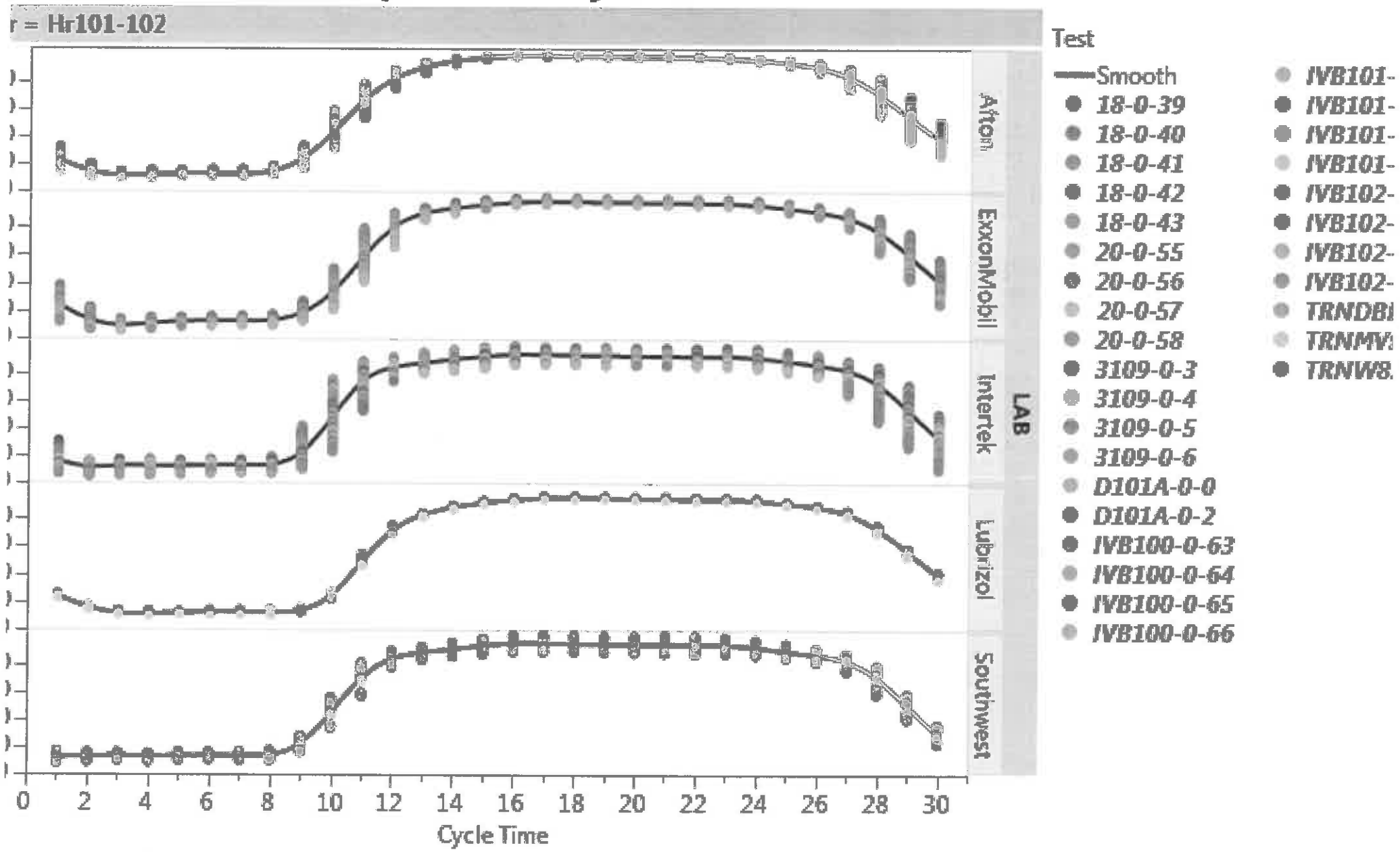
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Oil Gallery Pressure vs. Cycle Time

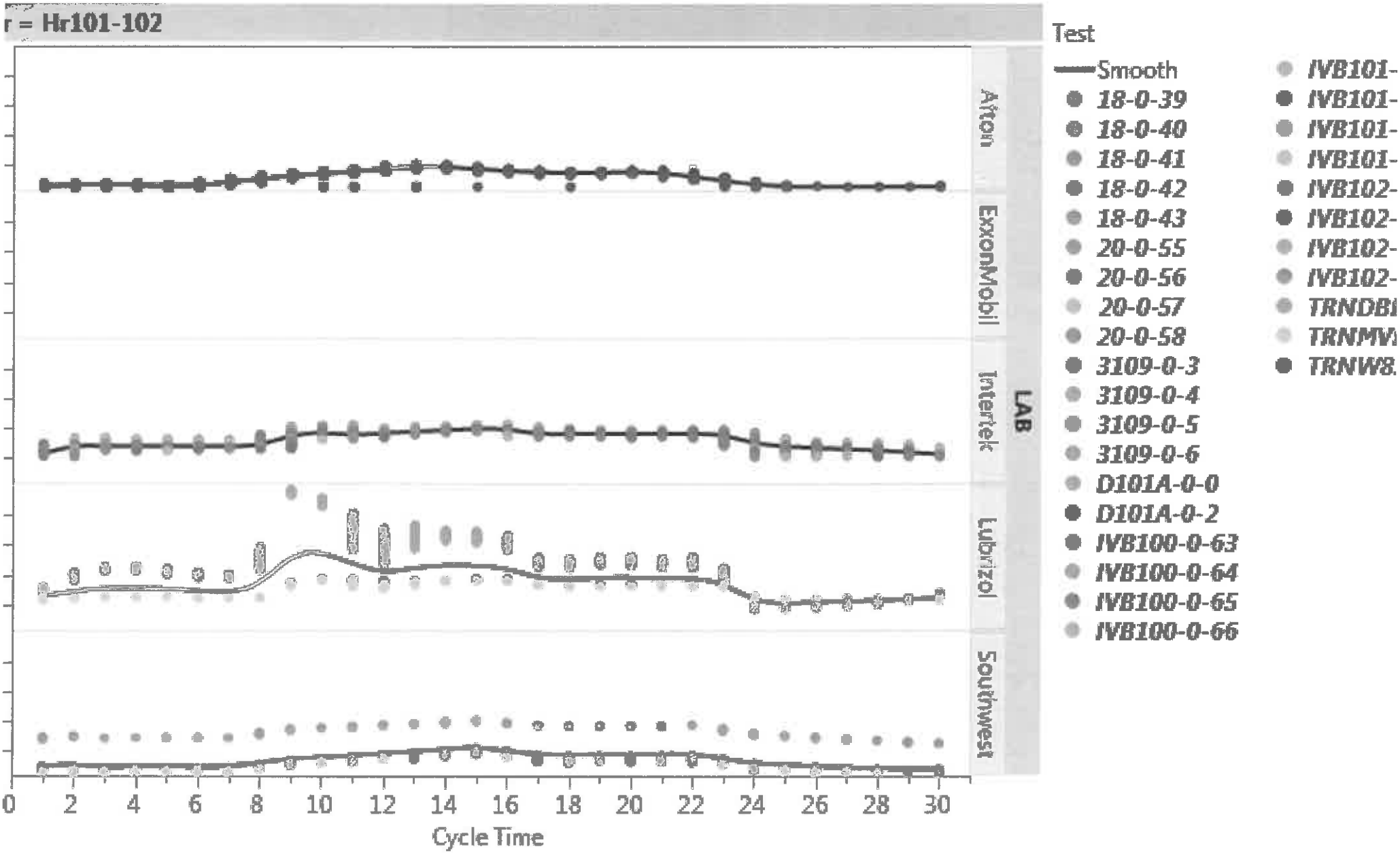


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Pedal Position vs. Cycle Time

r = Hr101-102



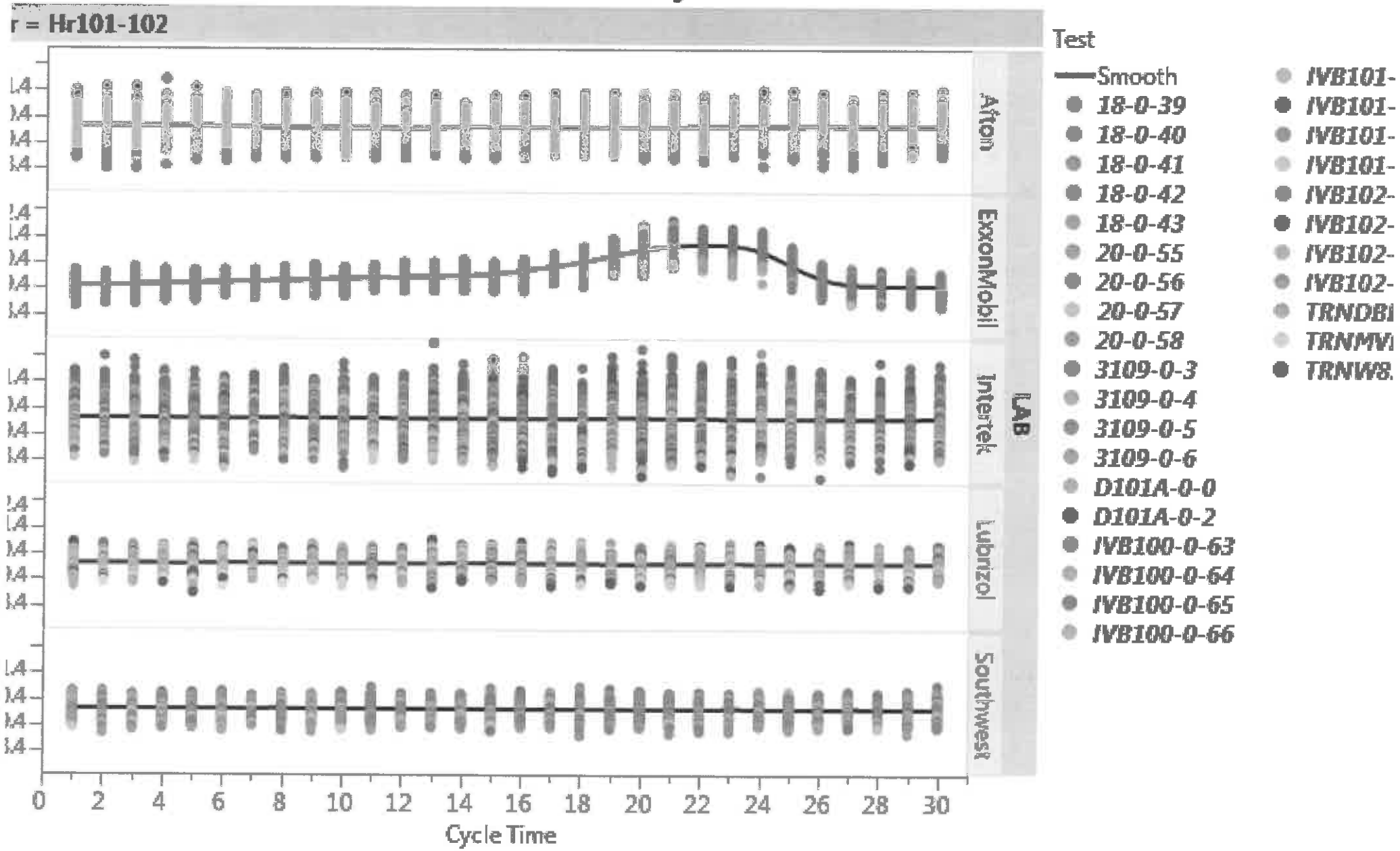
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMV
- TRNW8

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

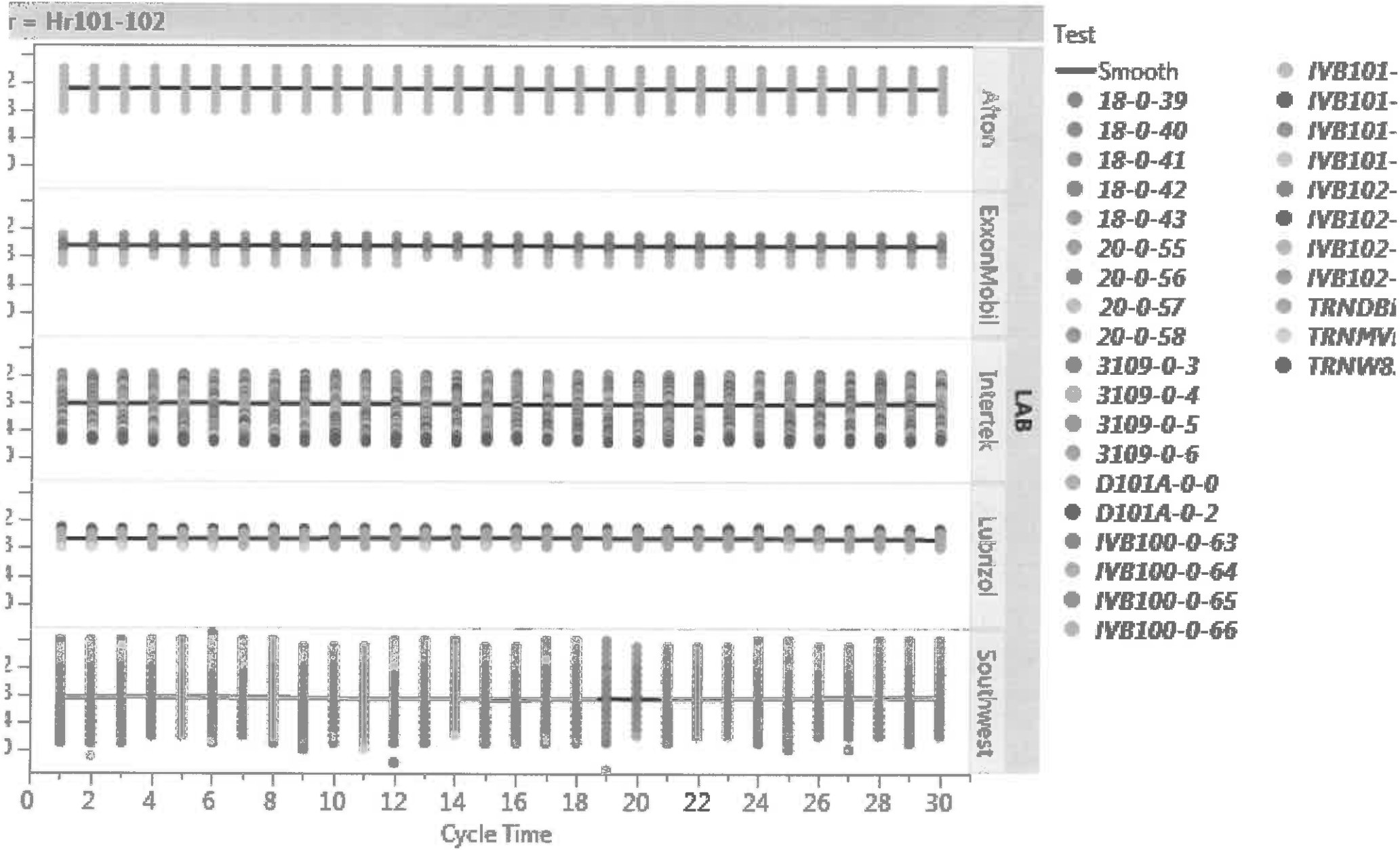
Rocker Cover Coolant Flow Rate vs. Cycle Time



(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Rocker Cover Coolant In Temp. vs. Cycle Time

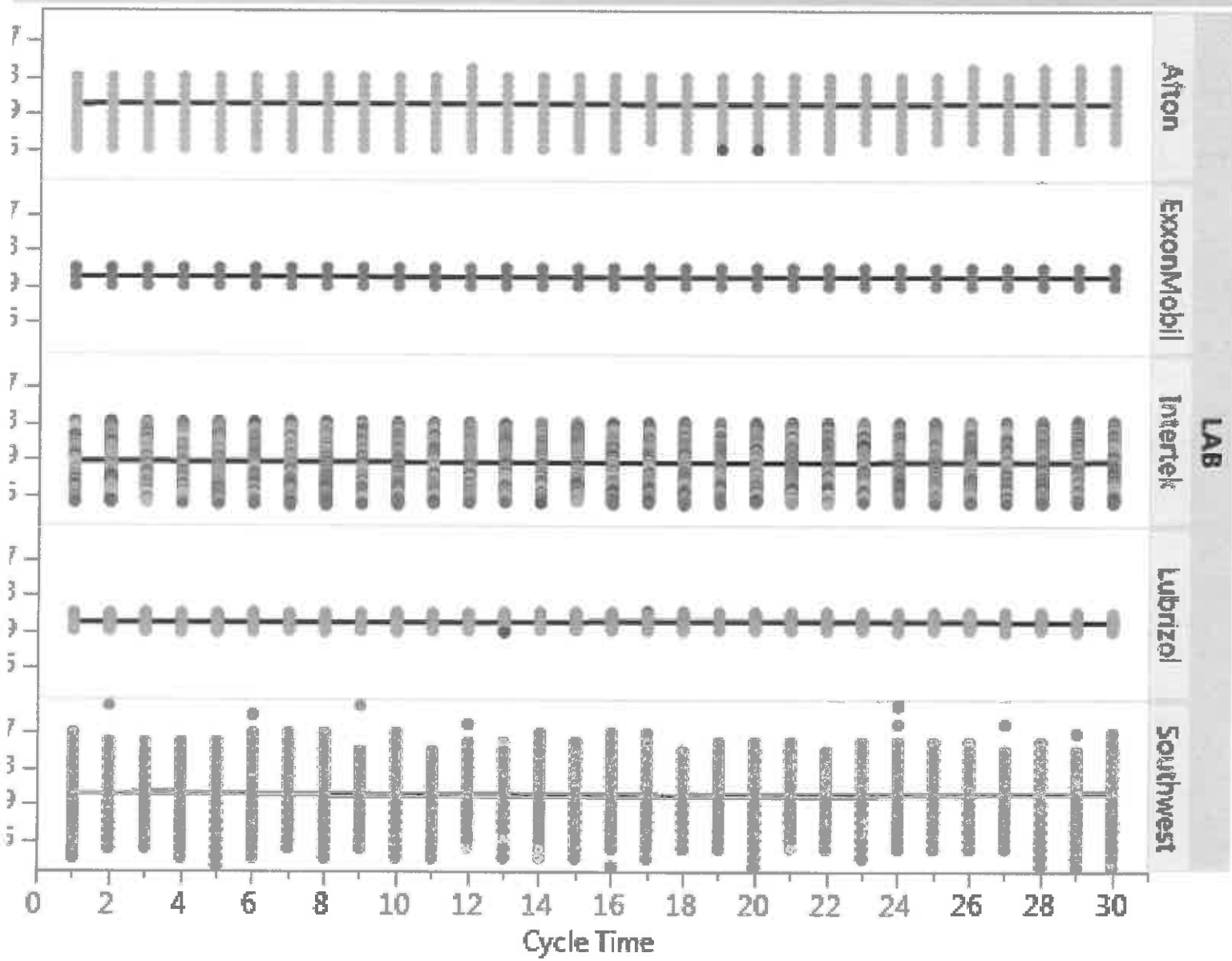


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Rocker Cover Coolant Out Temp. vs. Cycle Time

r = Hr101-102



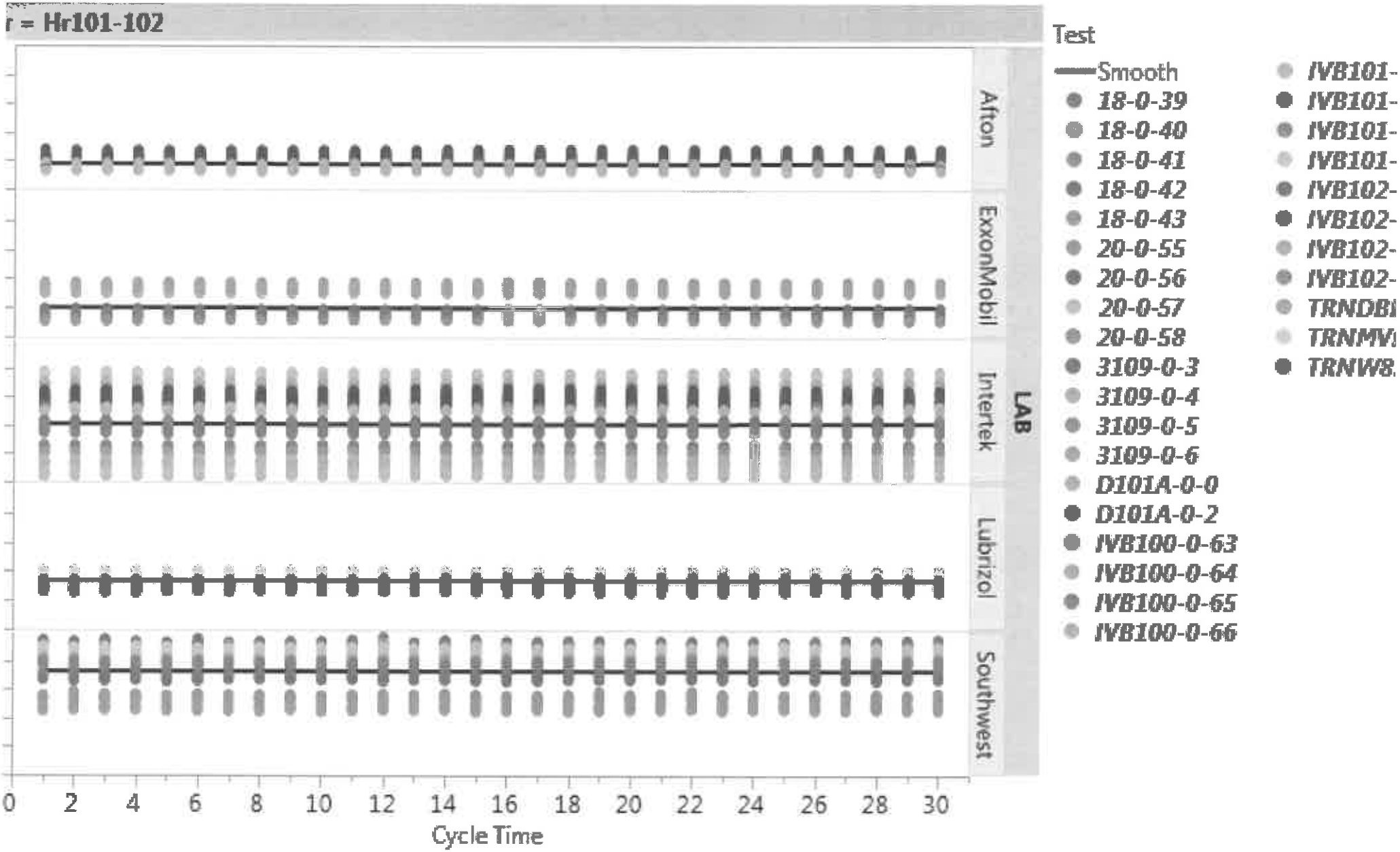
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Test Cell Air Temperature vs. Cycle Time

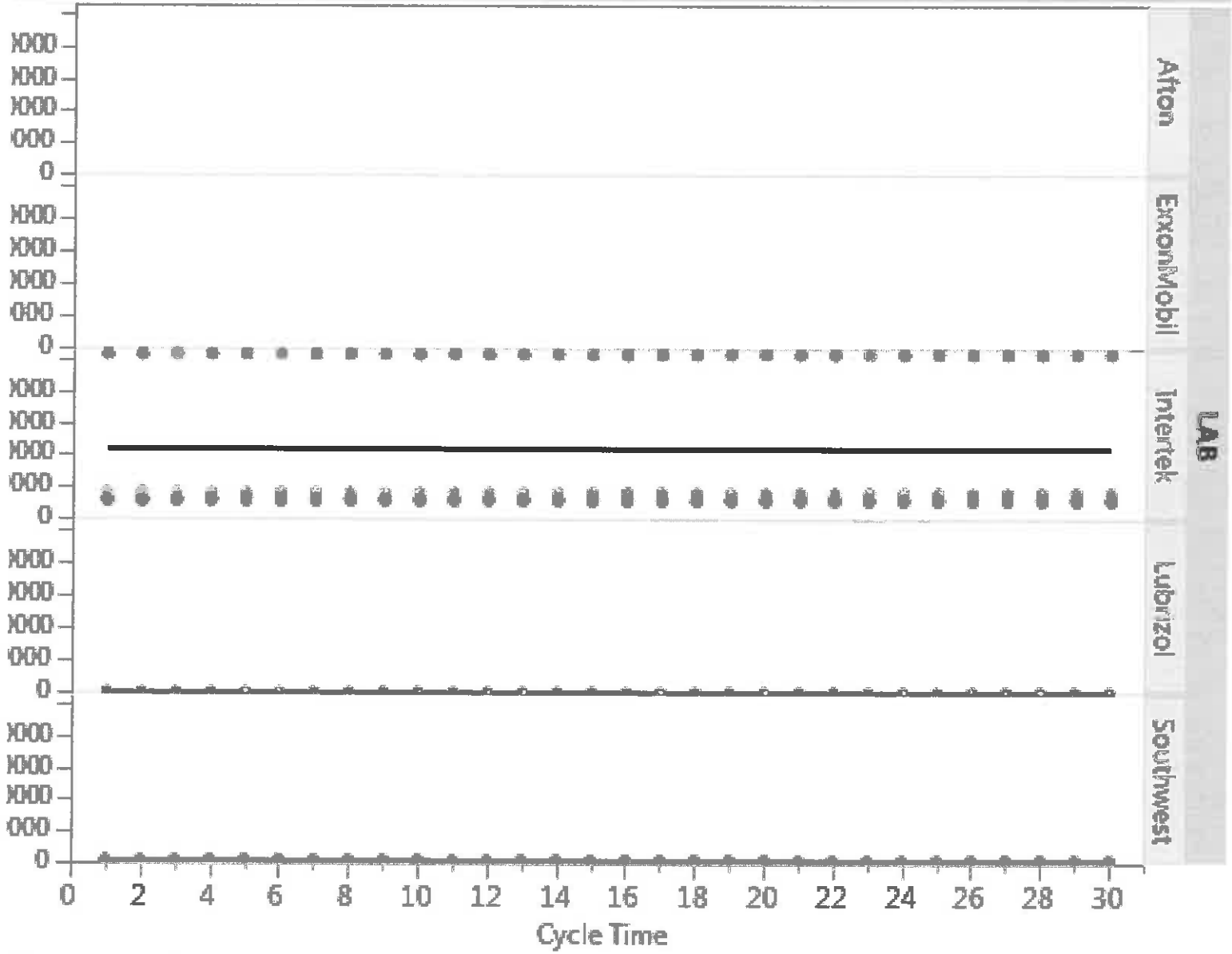


(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Total Fuel Used vs. Cycle Time

r = Hr101-102



Test

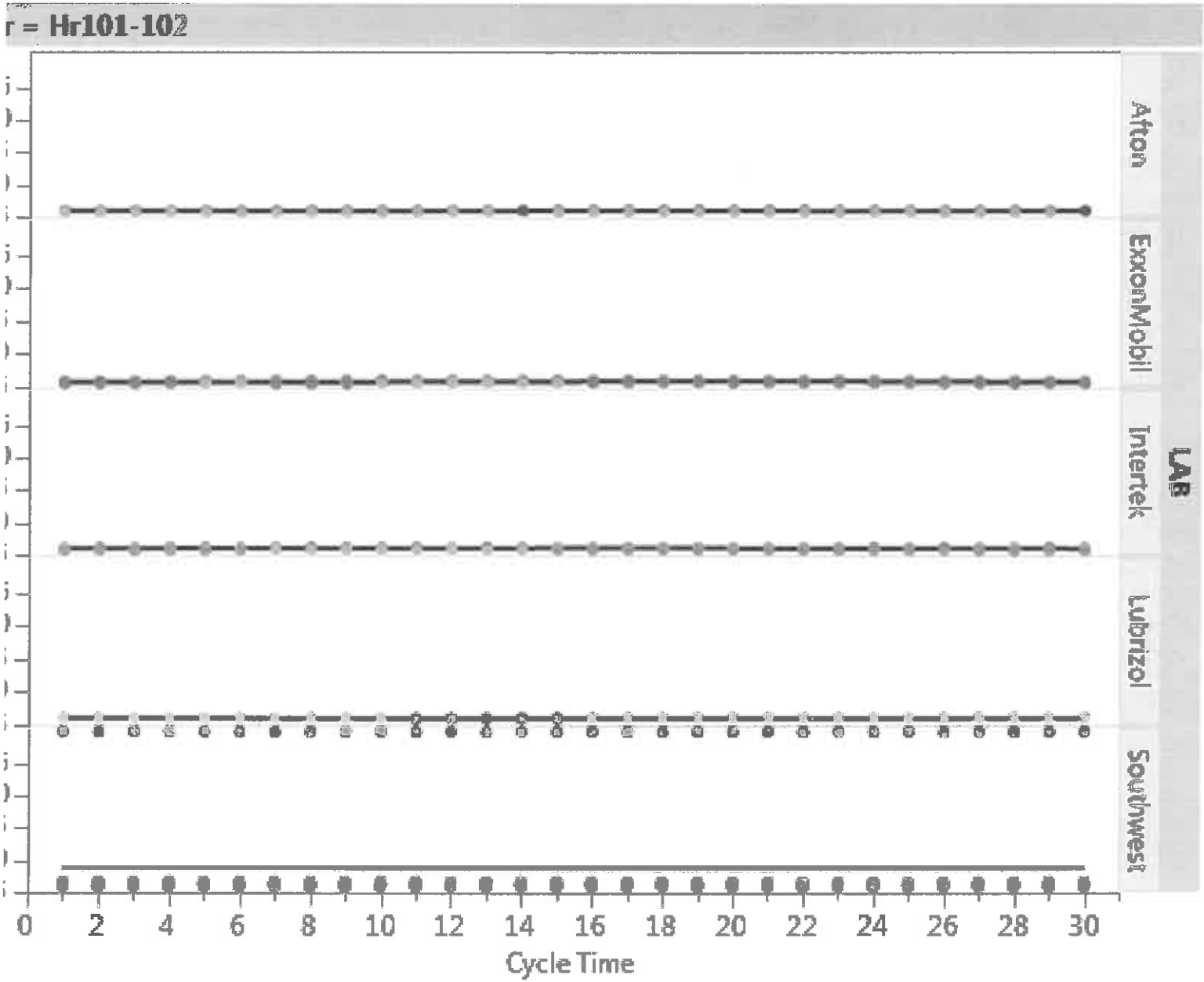
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMV
- TRNW8

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Valve Cover Blowby Gas Out vs. Cycle Time

r = Hr101-102



Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8

(TestHr = Hr101-102) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

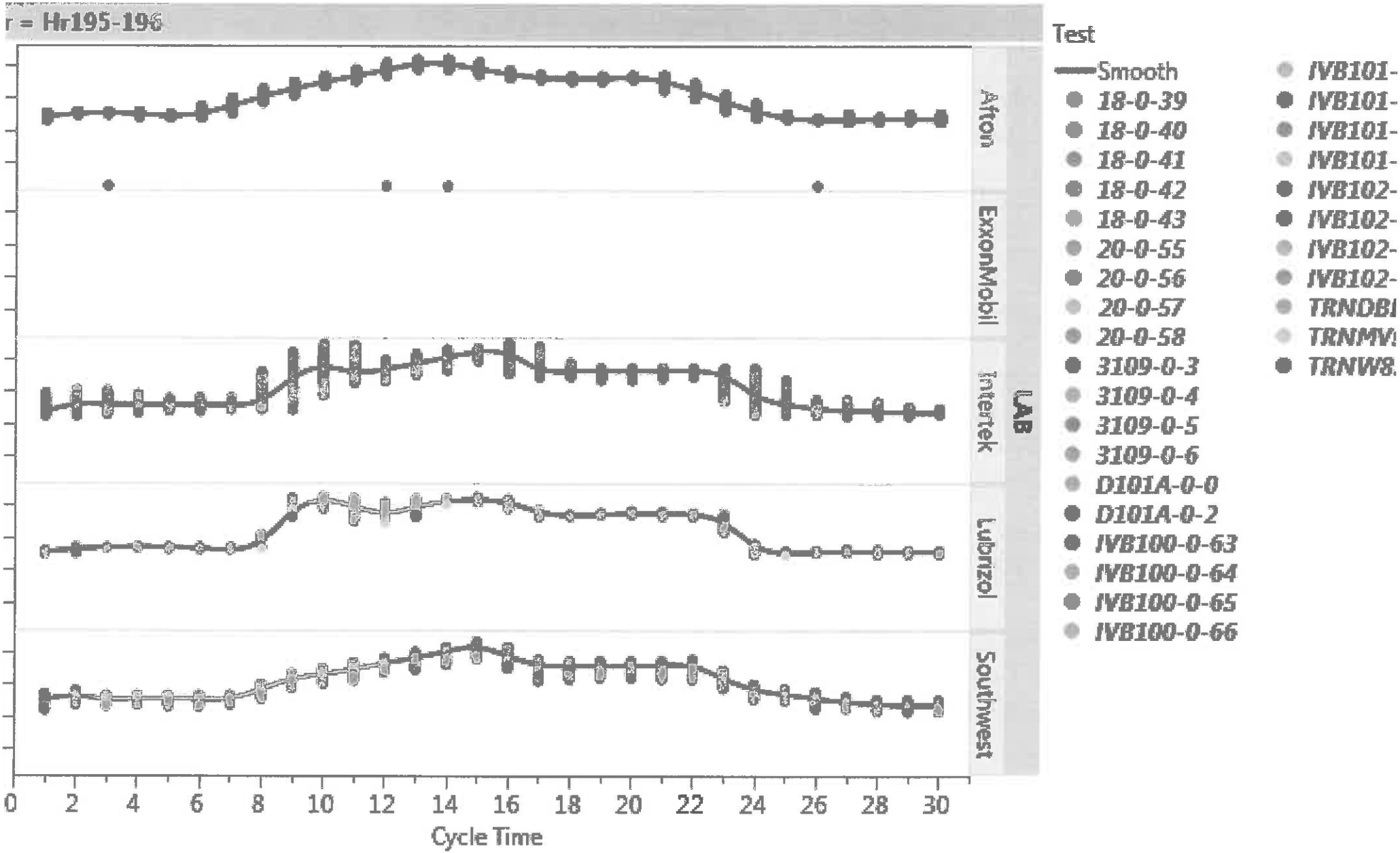
Operational Plots for All Labs Hrs 195-196, Exclusively

By: Stats Group

02-28-18

h Builder

Abs. Throttle Position vs. Cycle Time

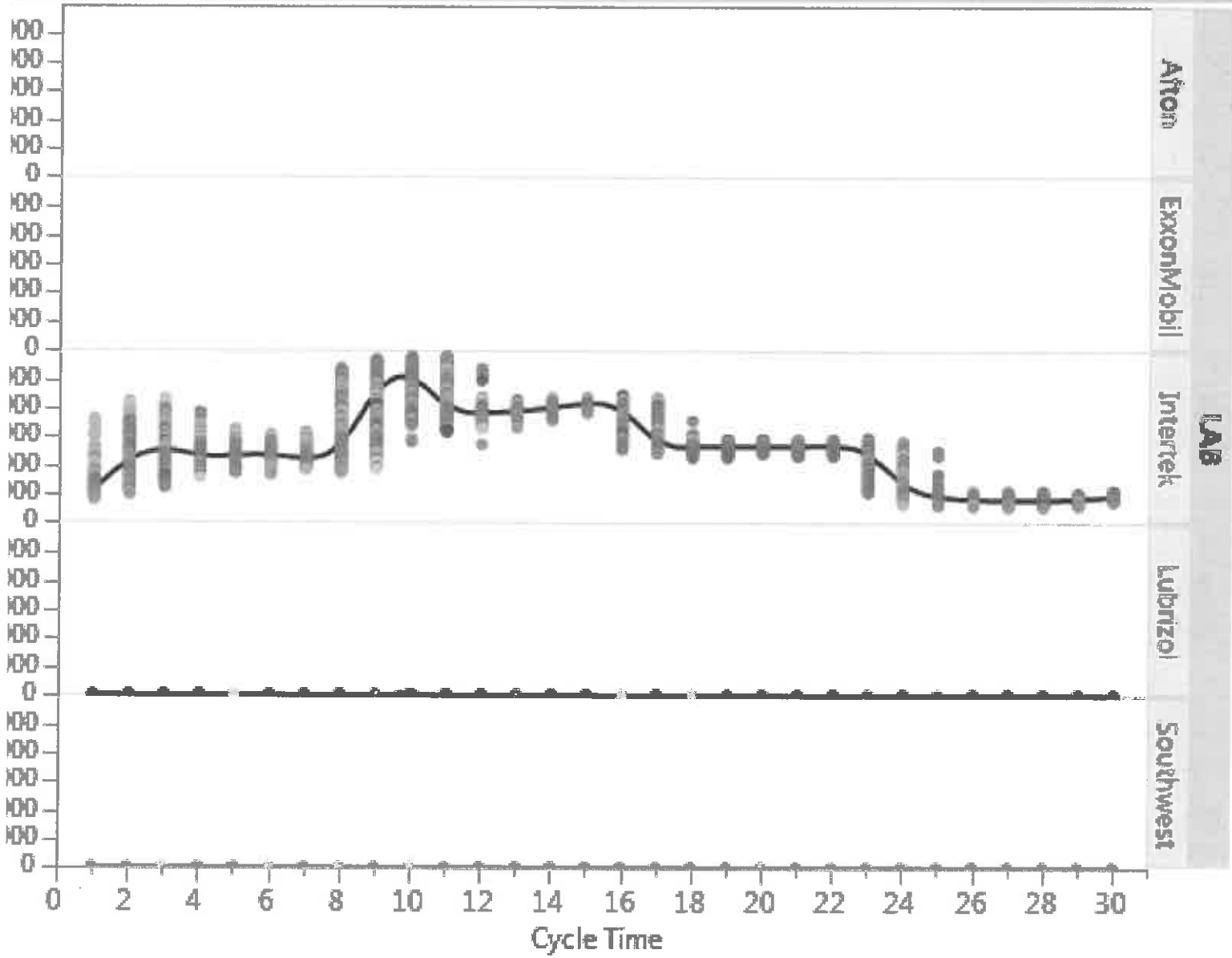


(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Absolute Load vs. Cycle Time

r = Hr195-196



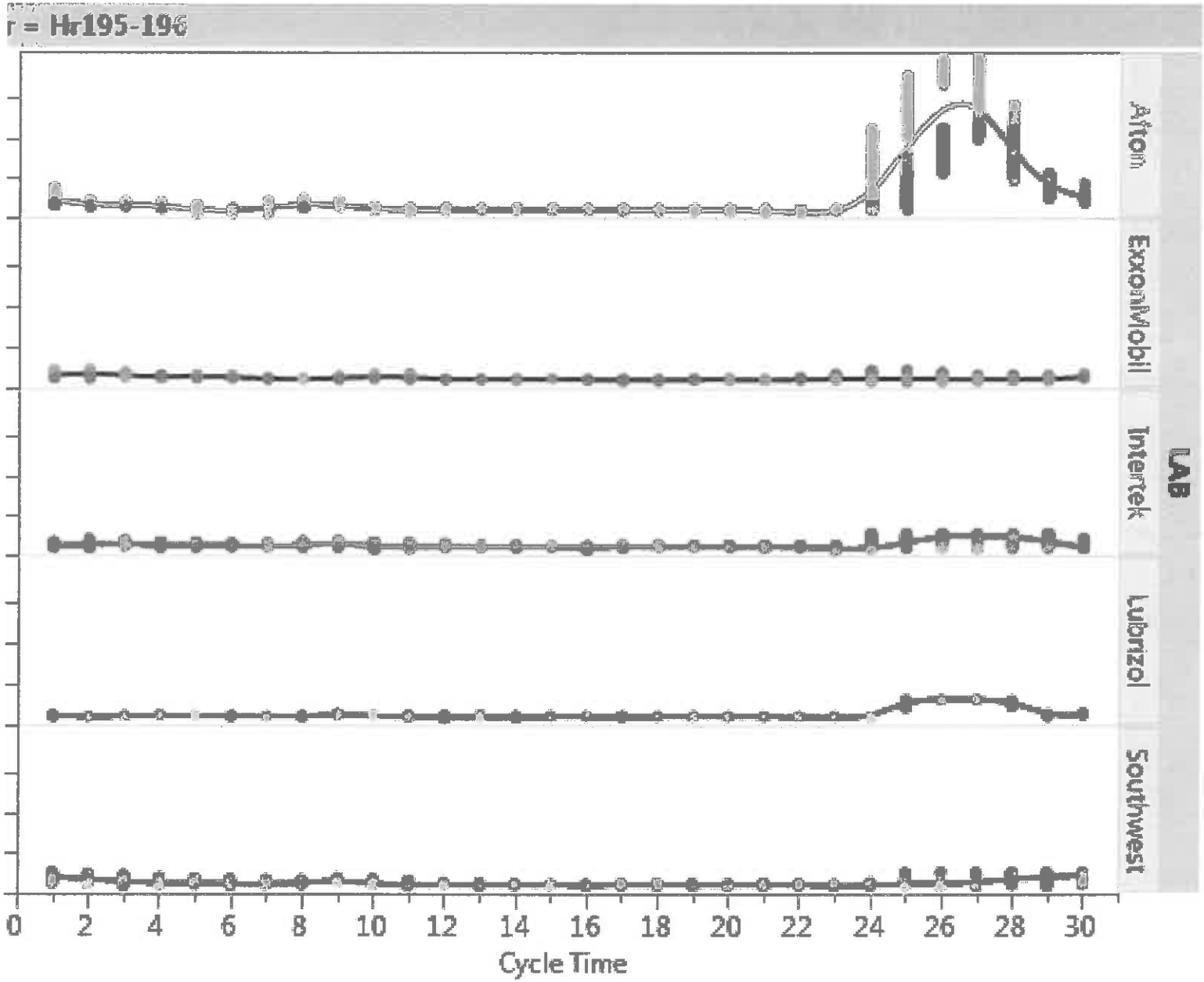
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Air Fuel Ratio vs. Cycle Time



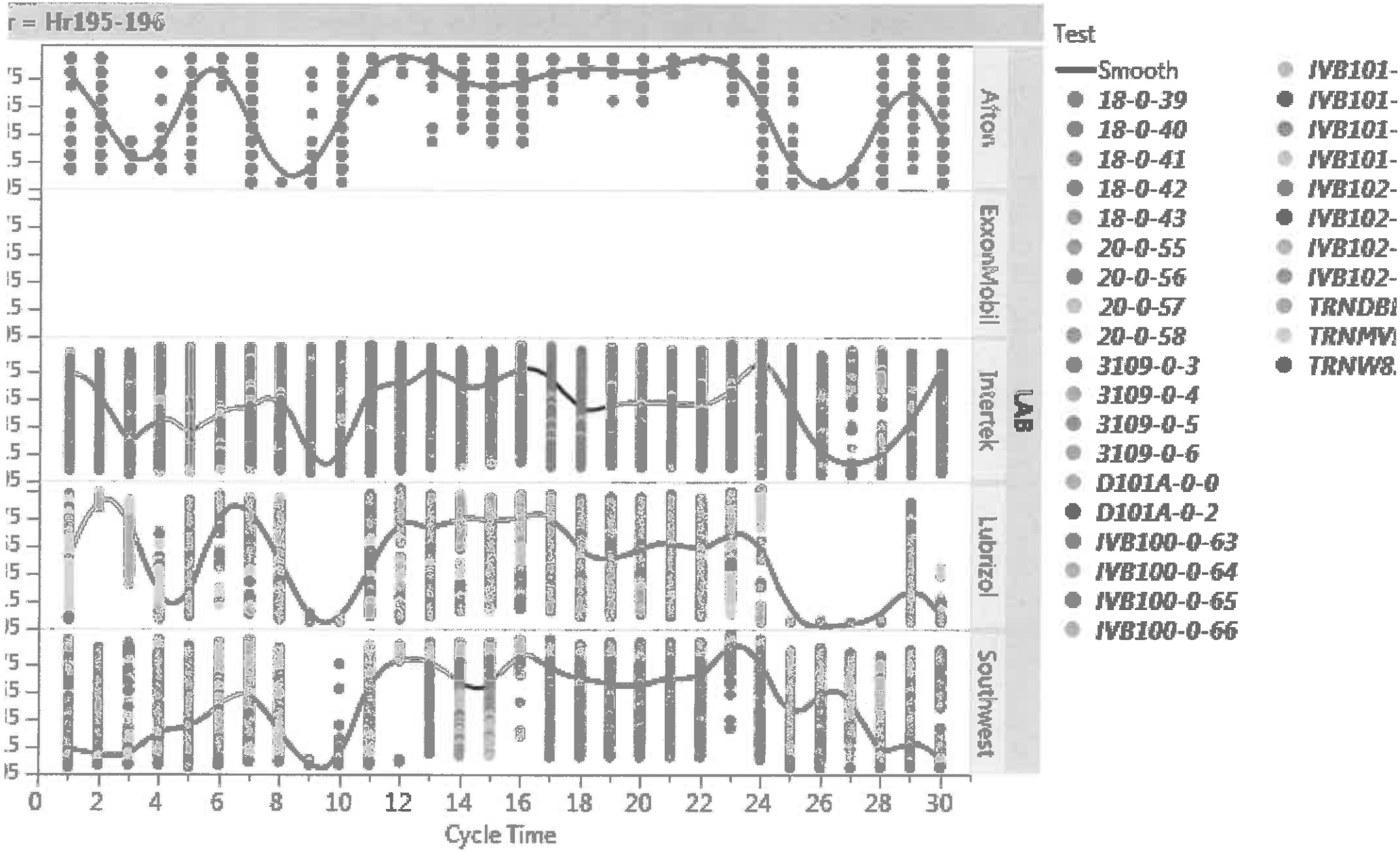
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

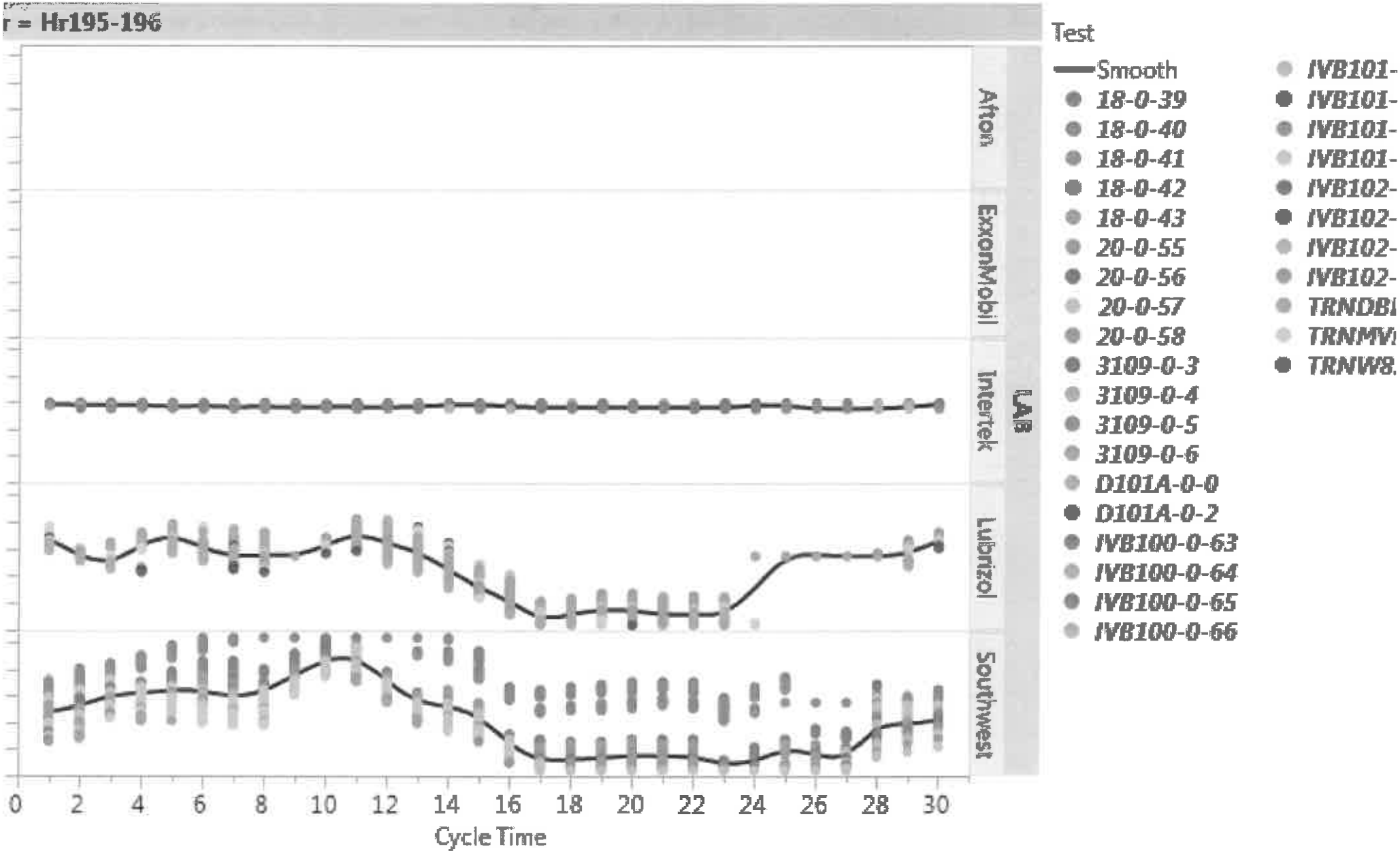
Bank 1 Sensor 1 vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

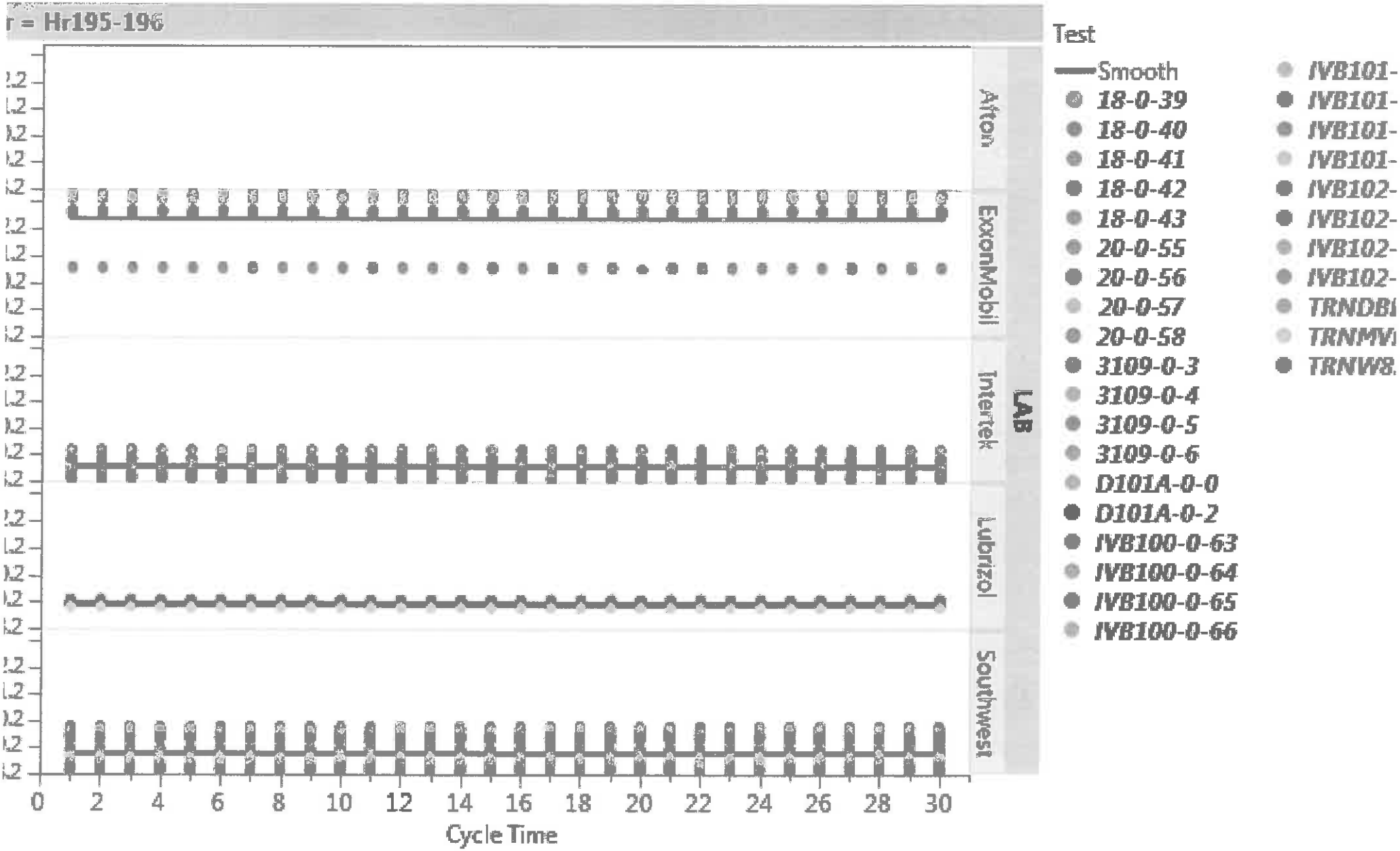
Bank 1 STFT vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Barometric Pressure vs. Cycle Time

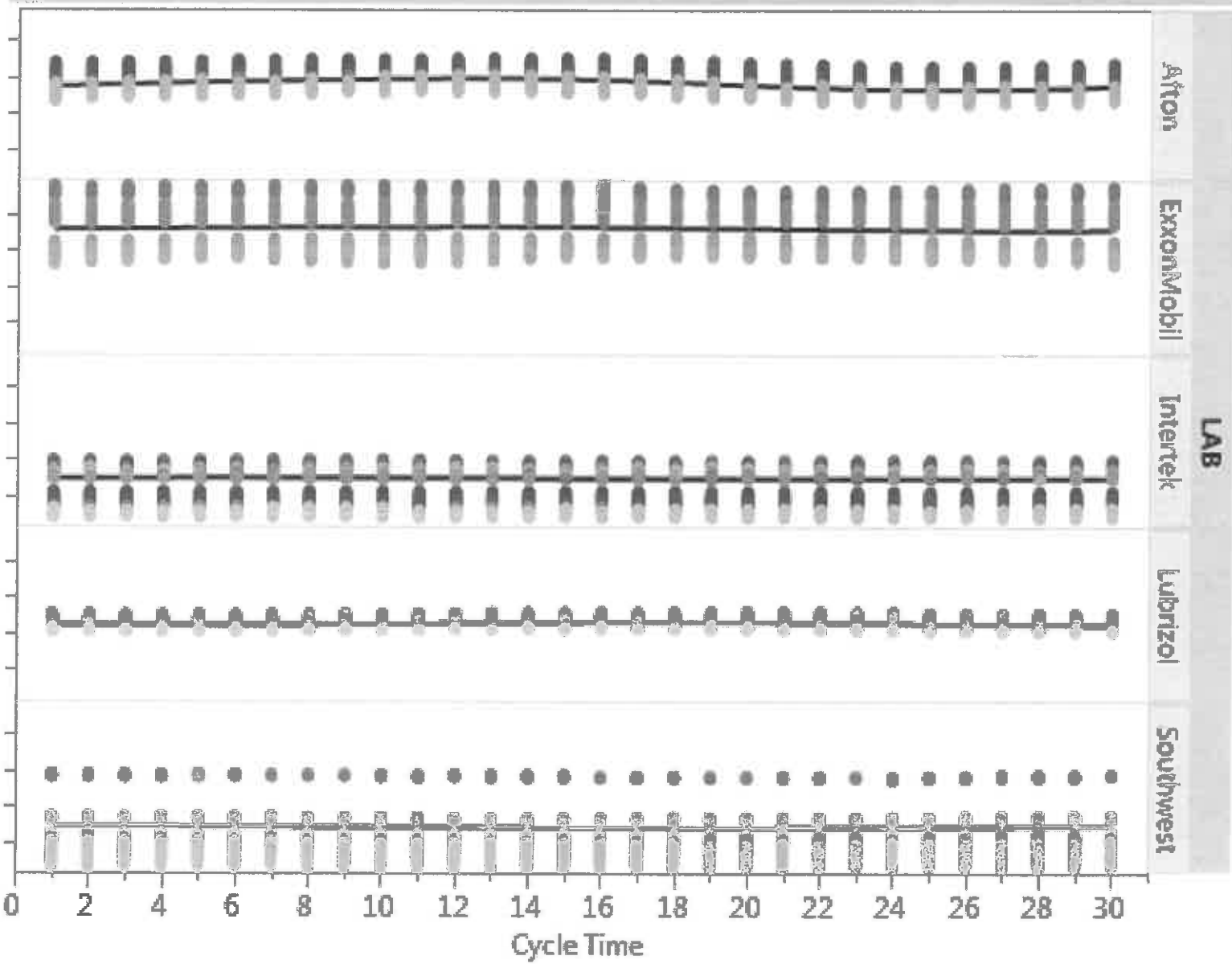


(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Blowby Coolant at Outlet vs. Cycle Time

r = Hr195-196



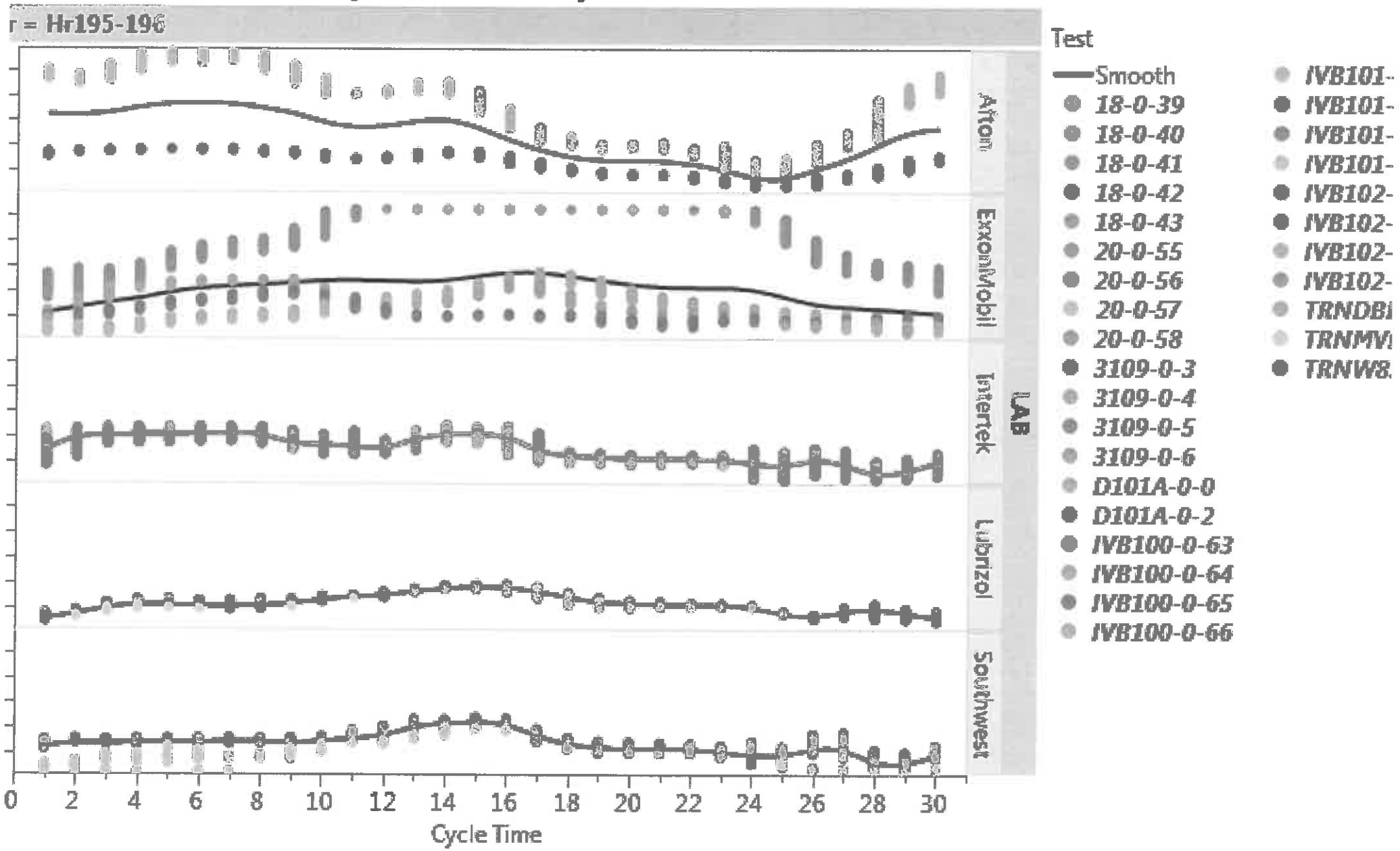
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

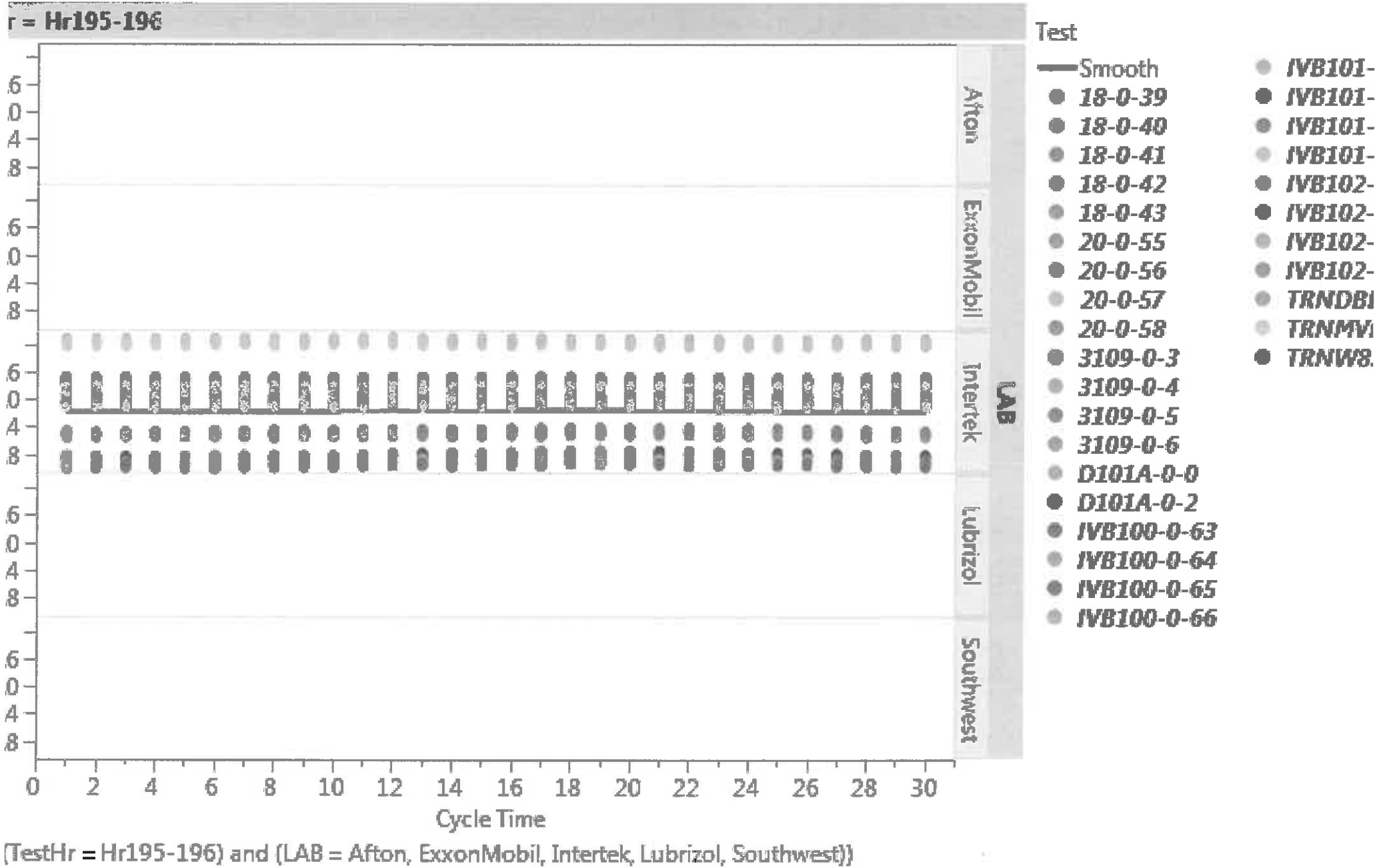
Blowby Flow Rate vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

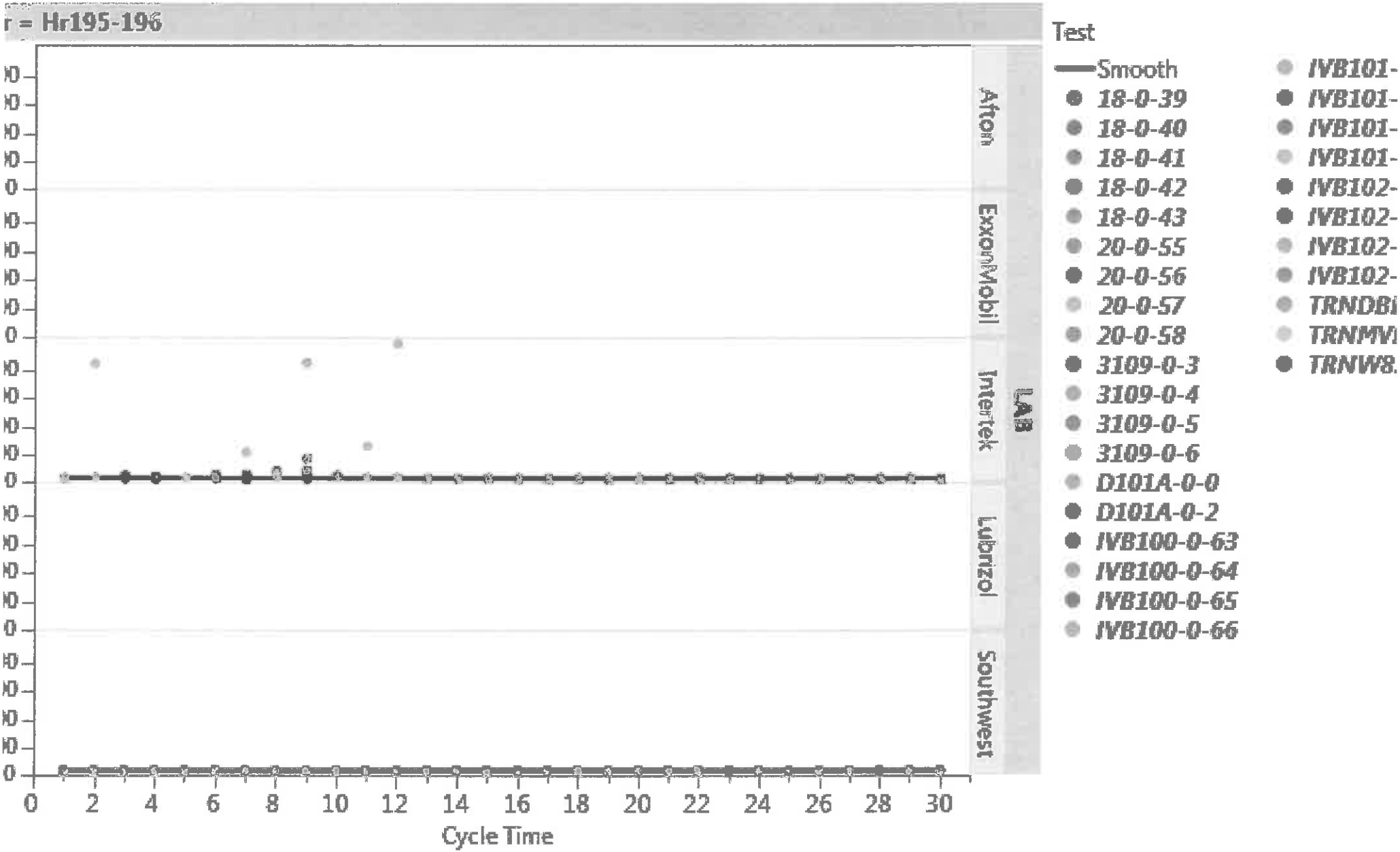
Blowby Gas in Oil Separator (IAR Optional) vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

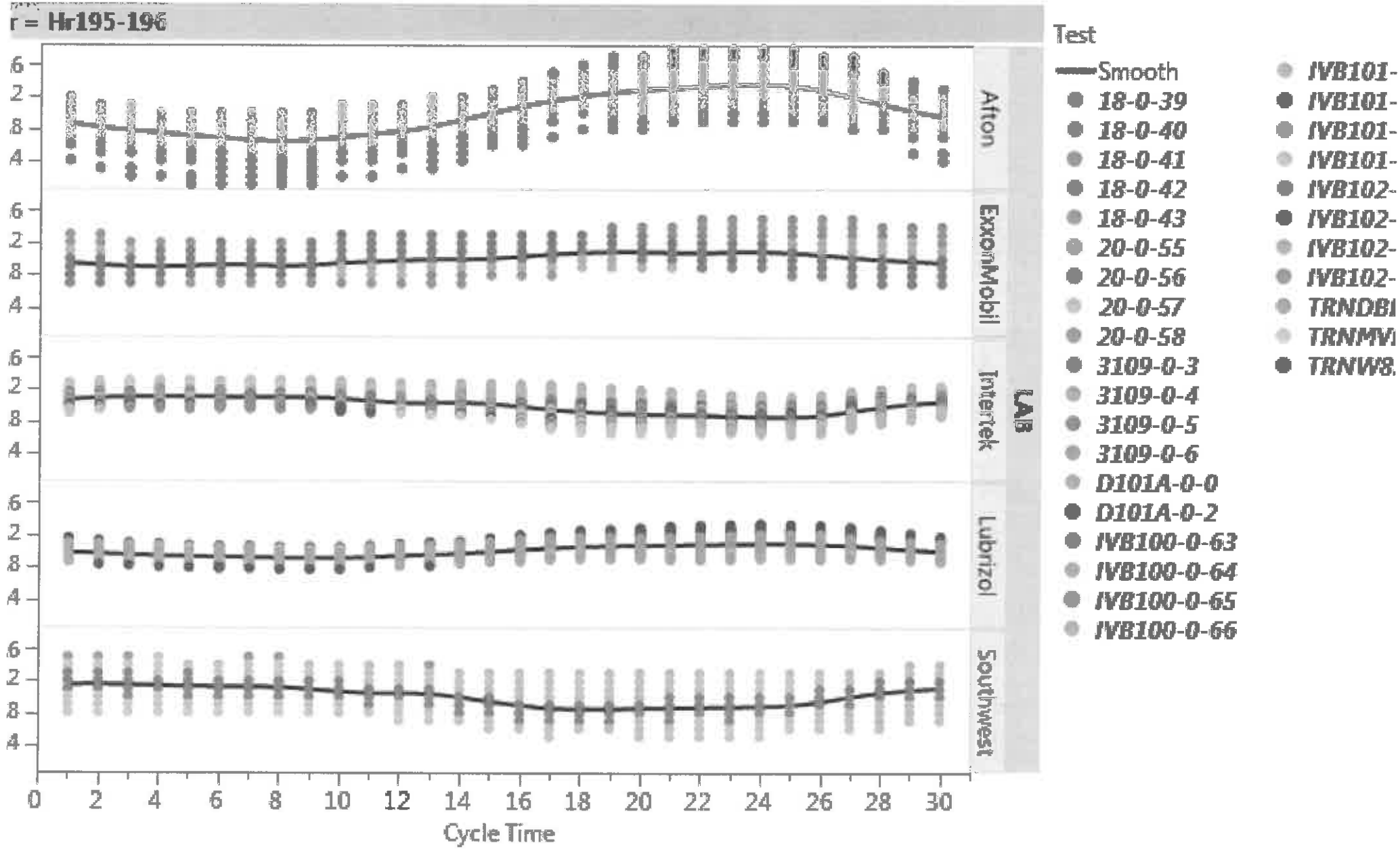
Blowby Gas in Oil Separator (Optional) vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Blowby Temperature (Controlled) vs. Cycle Time

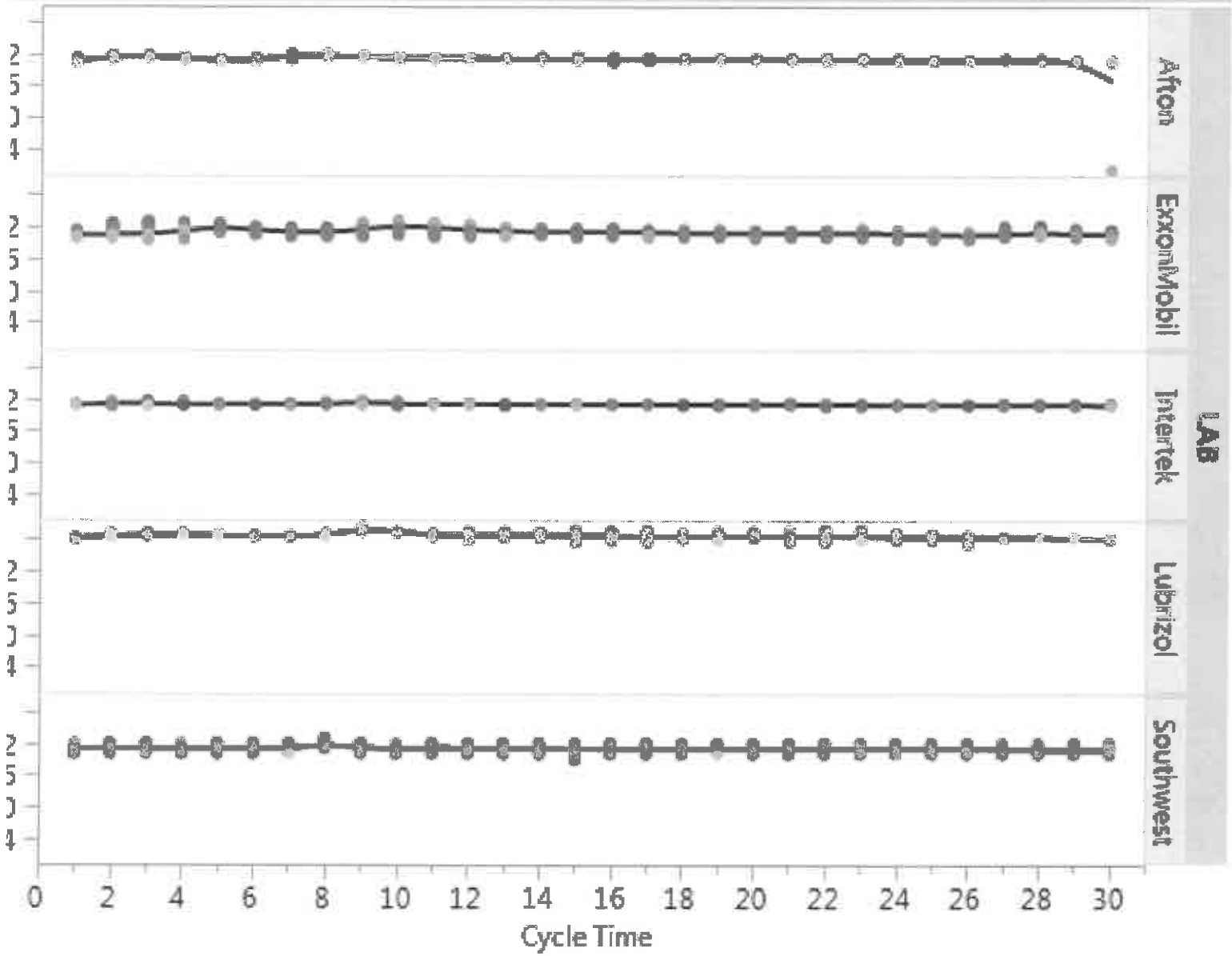


(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Brake Mean Effective Pressure vs. Cycle Time

r = Hr195-196



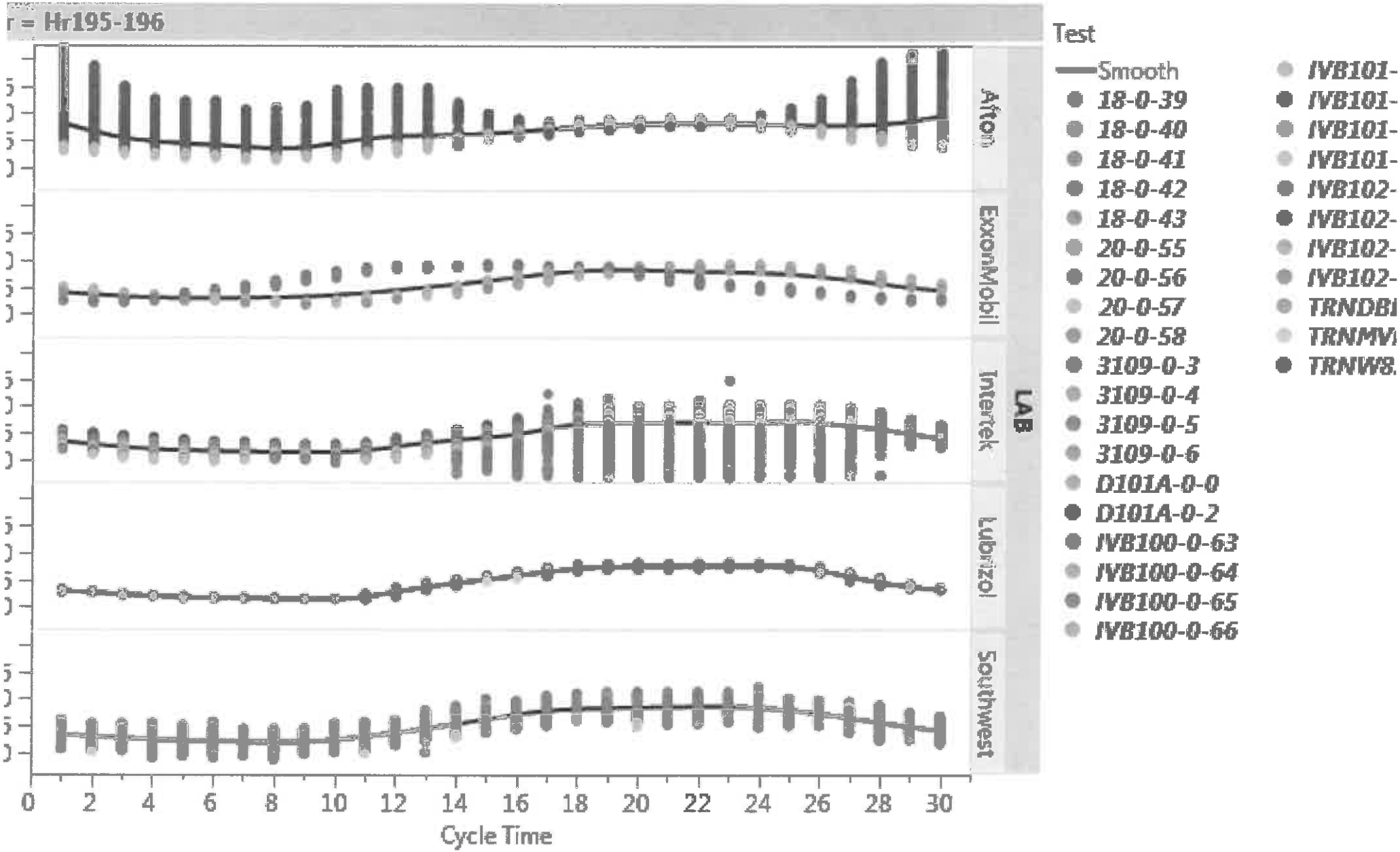
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

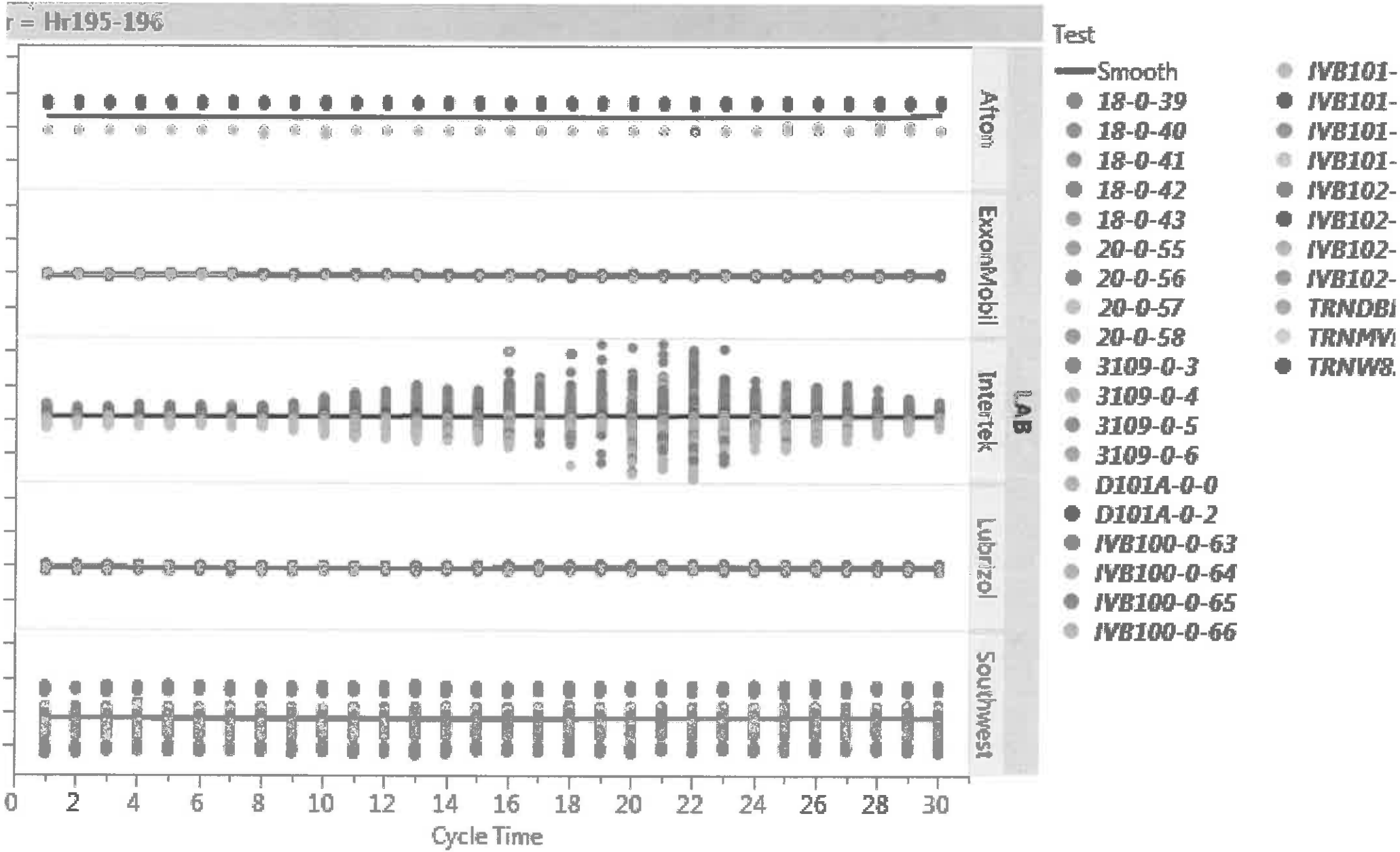
Coolant Delta vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

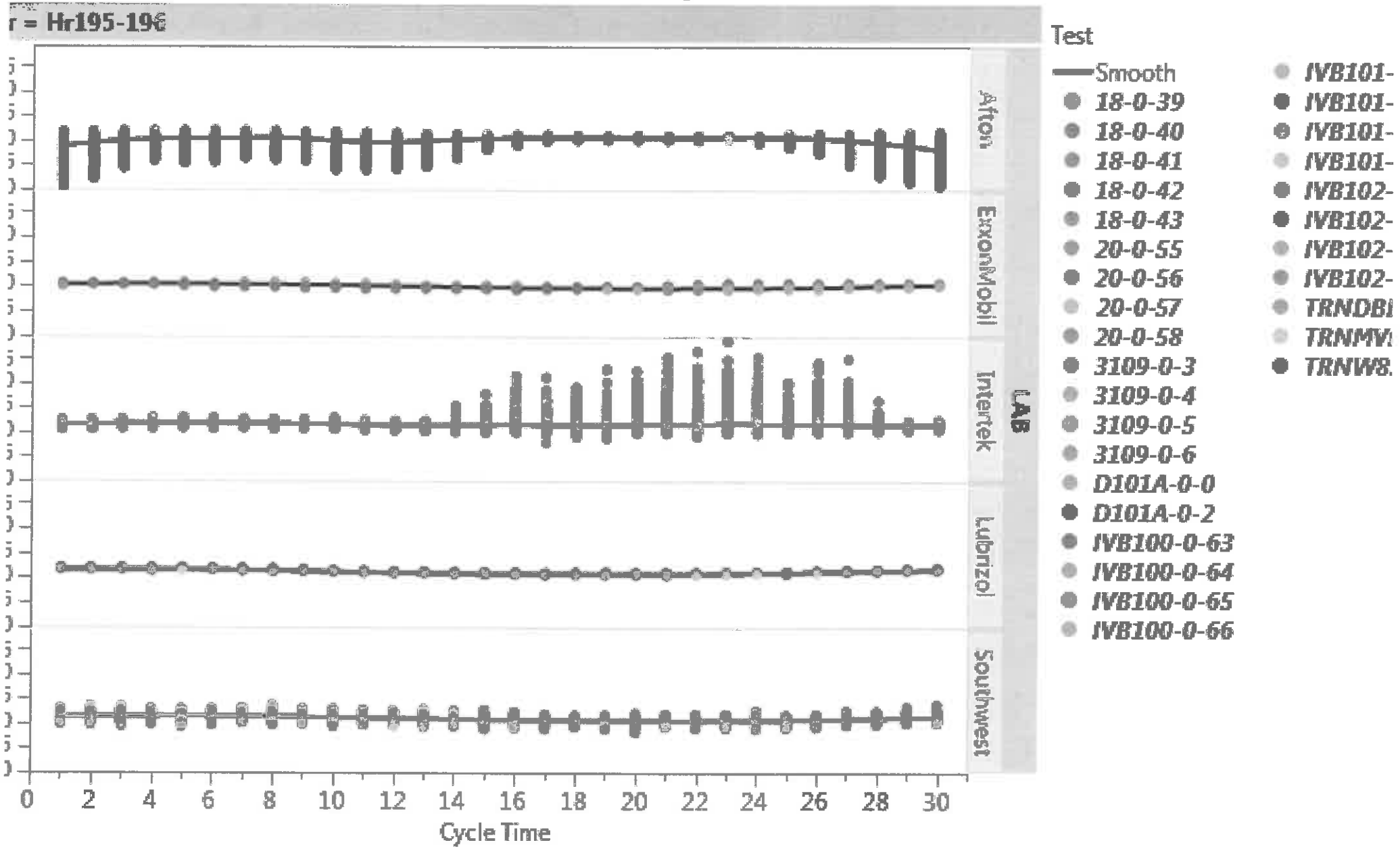
Coolant Inlet Pressure vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Temperature Into Engine vs. Cycle Time

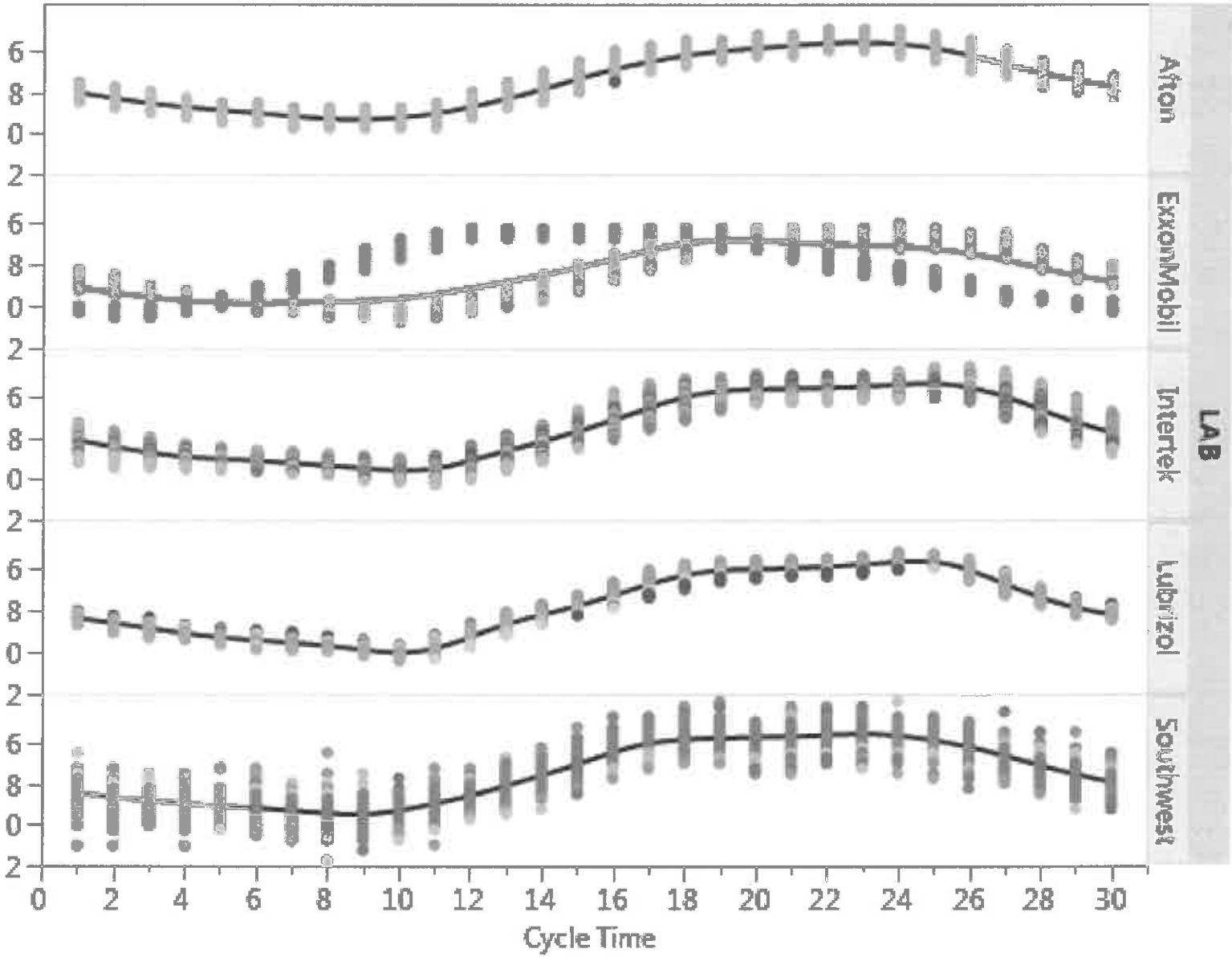


(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Coolant Temperature Out of Engine vs. Cycle Time

r = Hr195-196

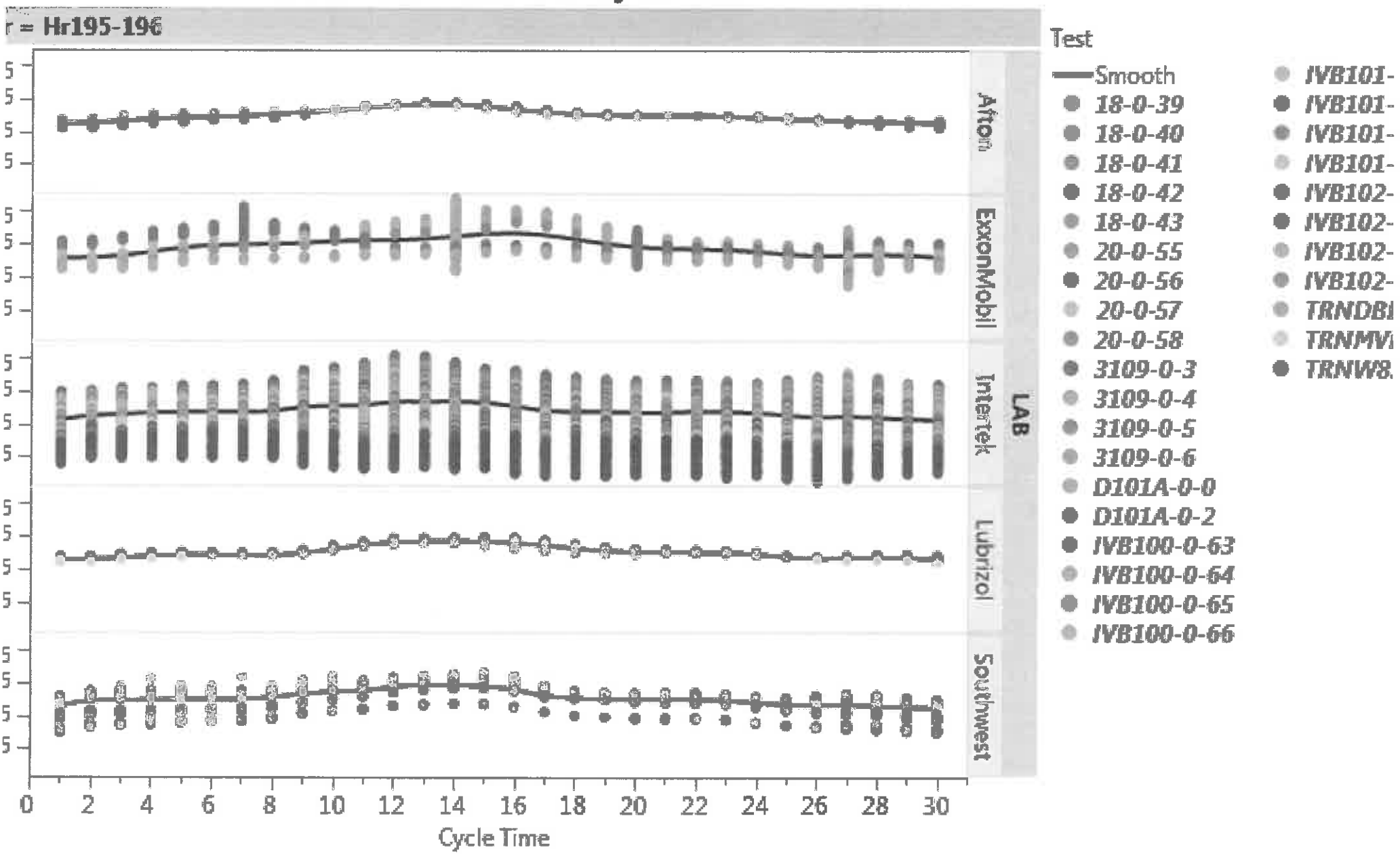


Test

Smooth
18-0-39
18-0-40
18-0-41
18-0-42
18-0-43
20-0-55
20-0-56
20-0-57
20-0-58
3109-0-3
3109-0-4
3109-0-5
3109-0-6
D101A-0-0
D101A-0-2
IVB100-0-63
IVB100-0-64
IVB100-0-65
IVB100-0-66
IVB101-
IVB101-
IVB101-
IVB101-
IVB102-
IVB102-
IVB102-
IVB102-
TRNDBI
TRNMVI
TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

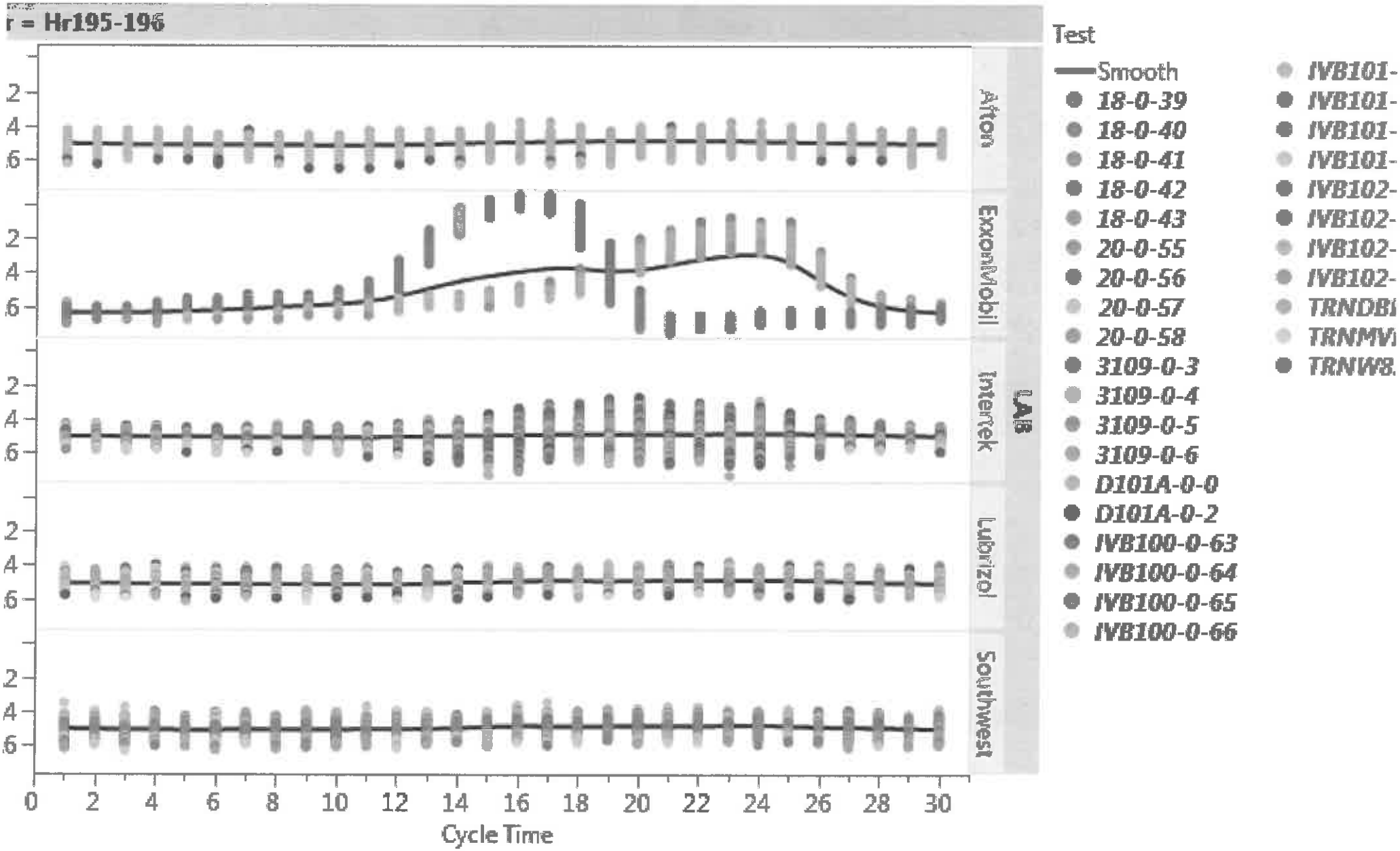
h Builder



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

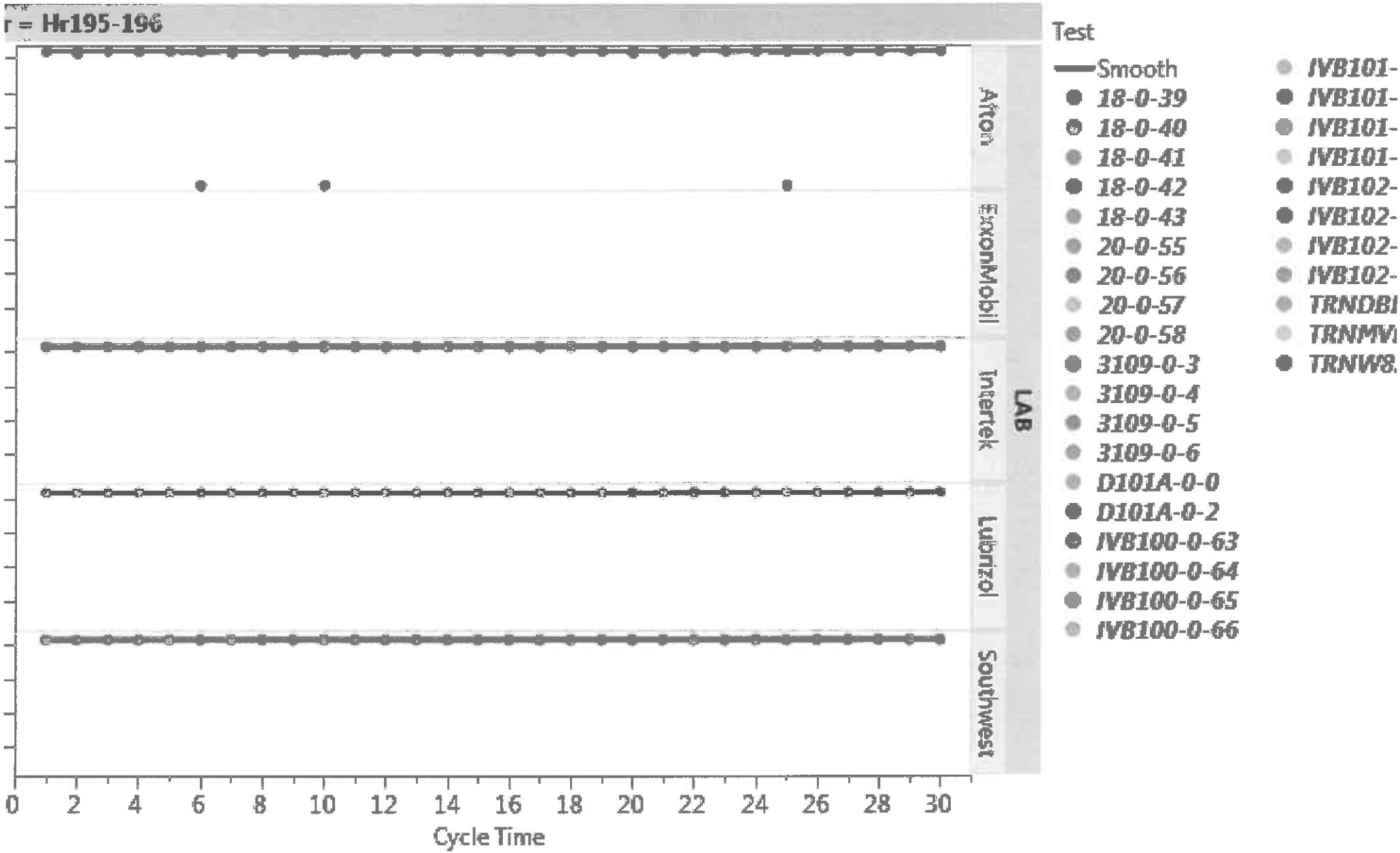
Engine Coolant Flow Rate vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

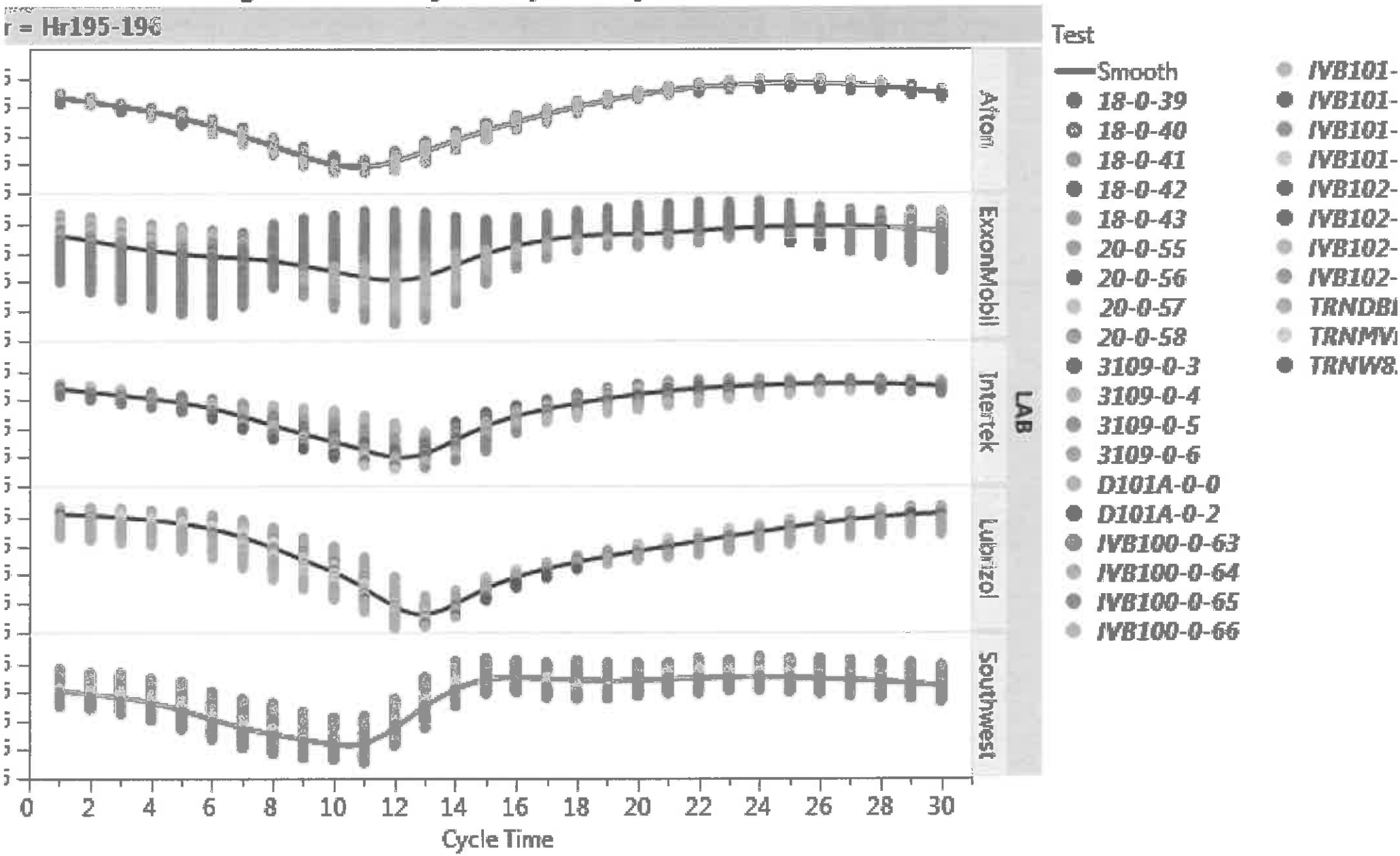
Engine Coolant Temp. vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

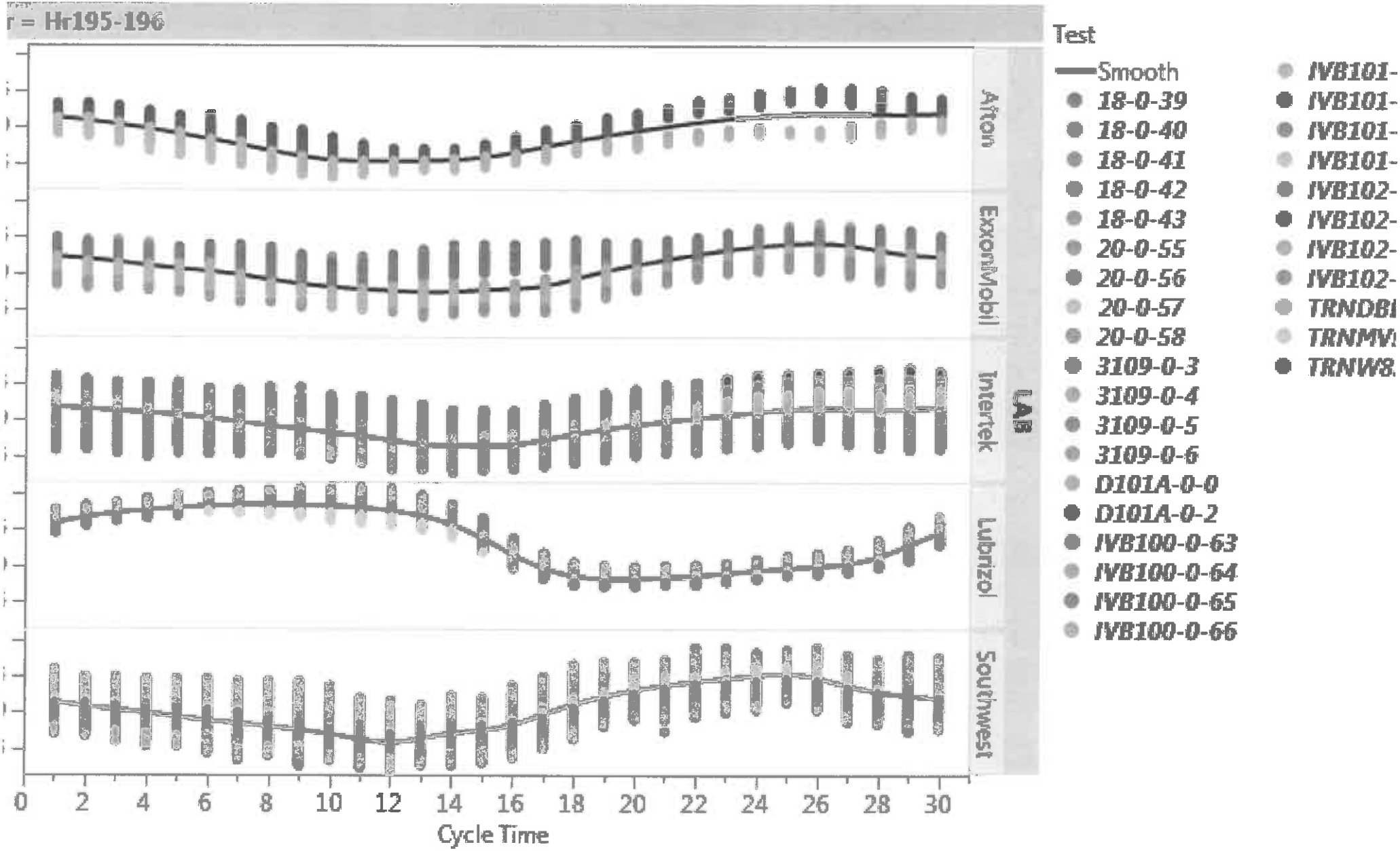
Engine Oil Gallery (Temp.) vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

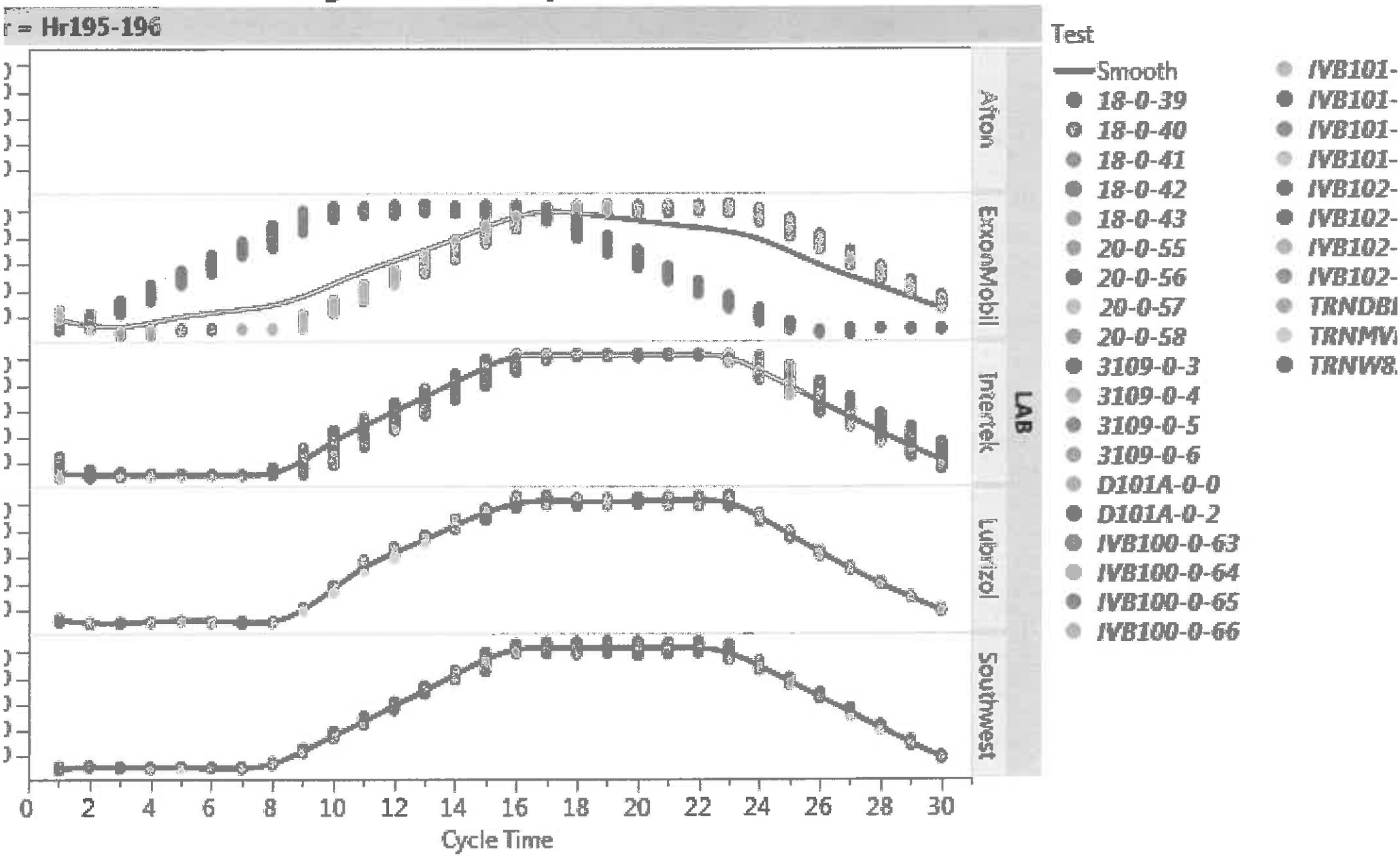
Engine Oil Sump (Temp.) vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

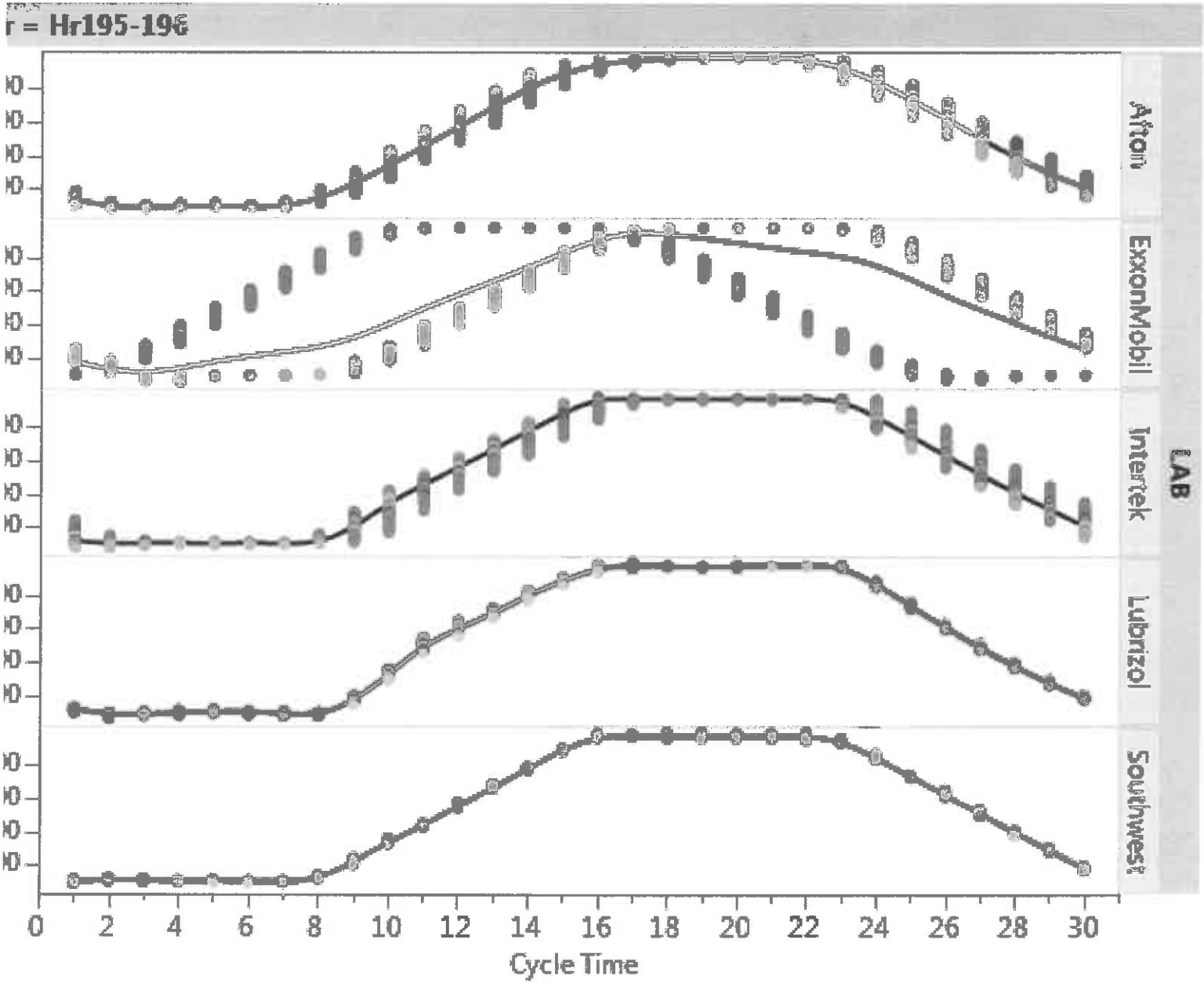
Engine Power vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Speed (Dyno) vs. Cycle Time



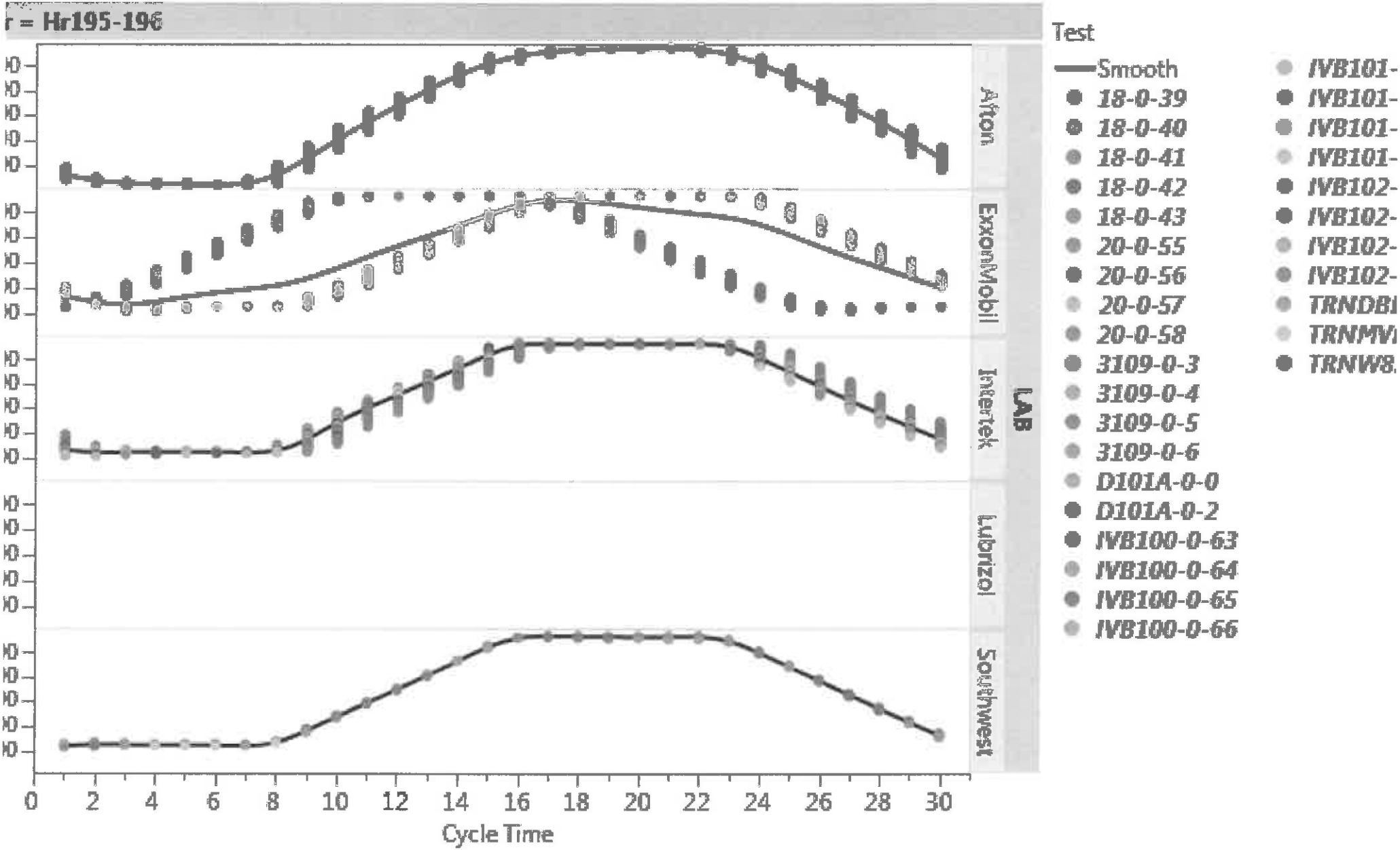
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

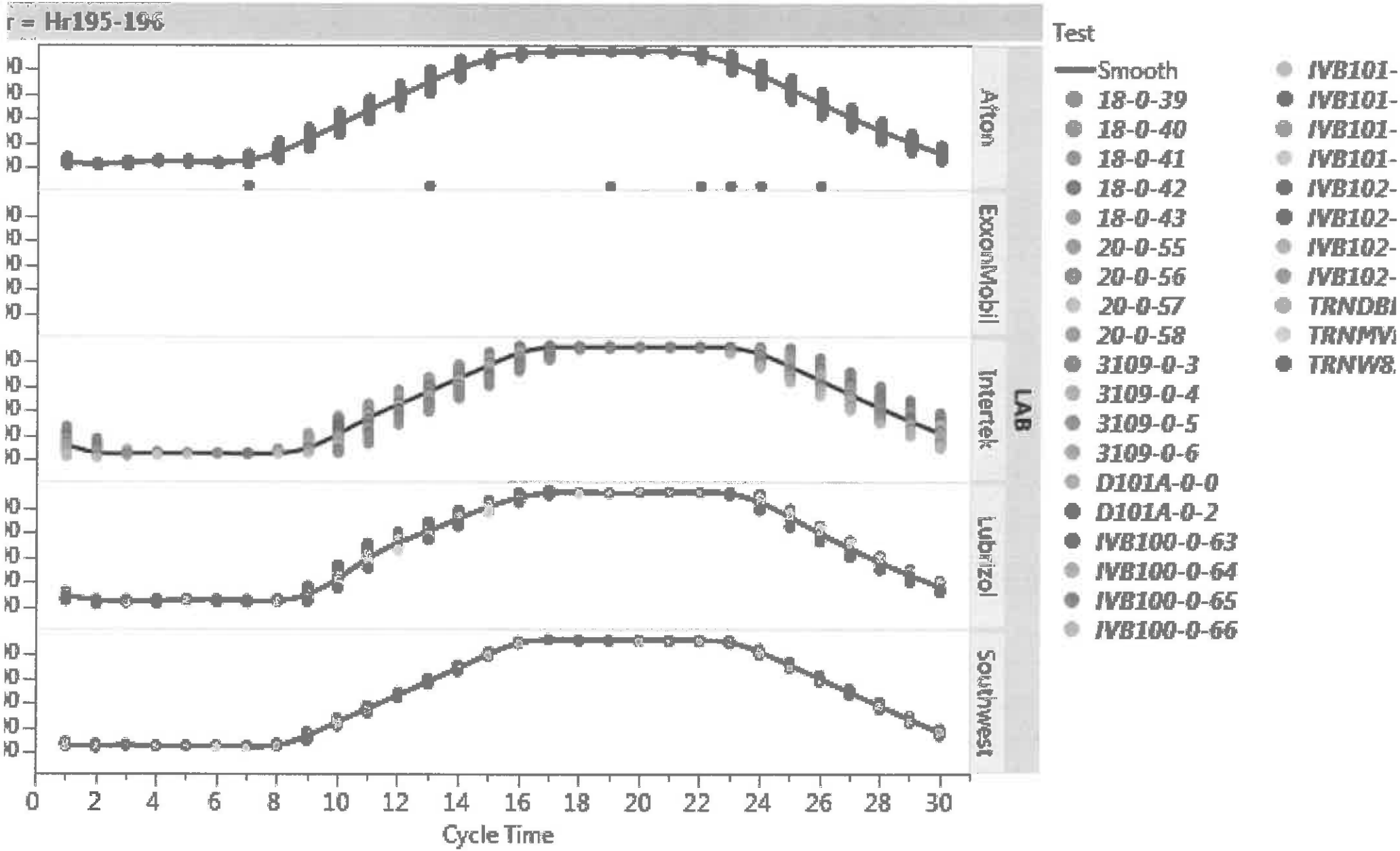
Engine Speed (Flywheel) vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Speed vs. Cycle Time

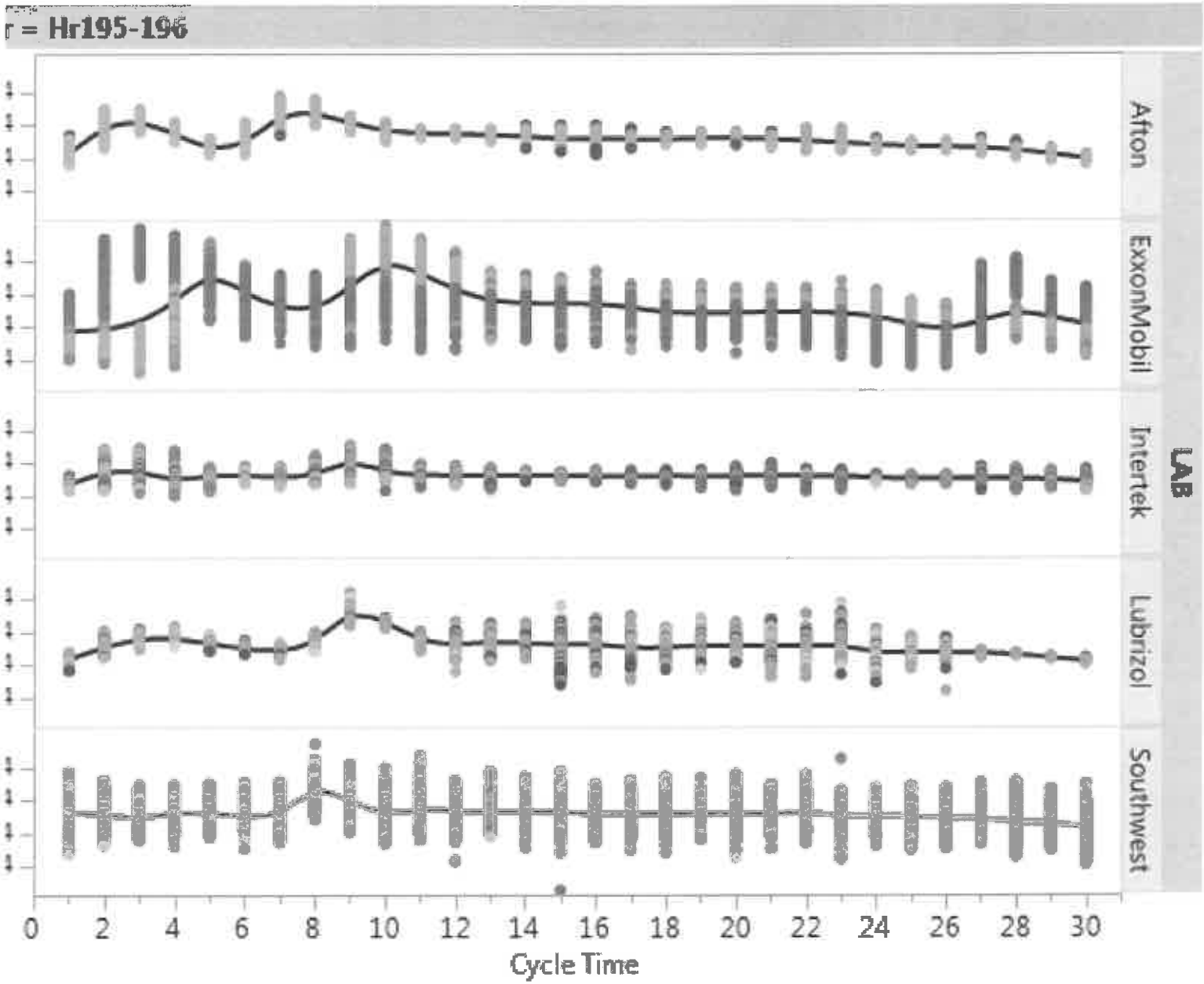


(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Engine Torque vs. Cycle Time

r = Hr195-196



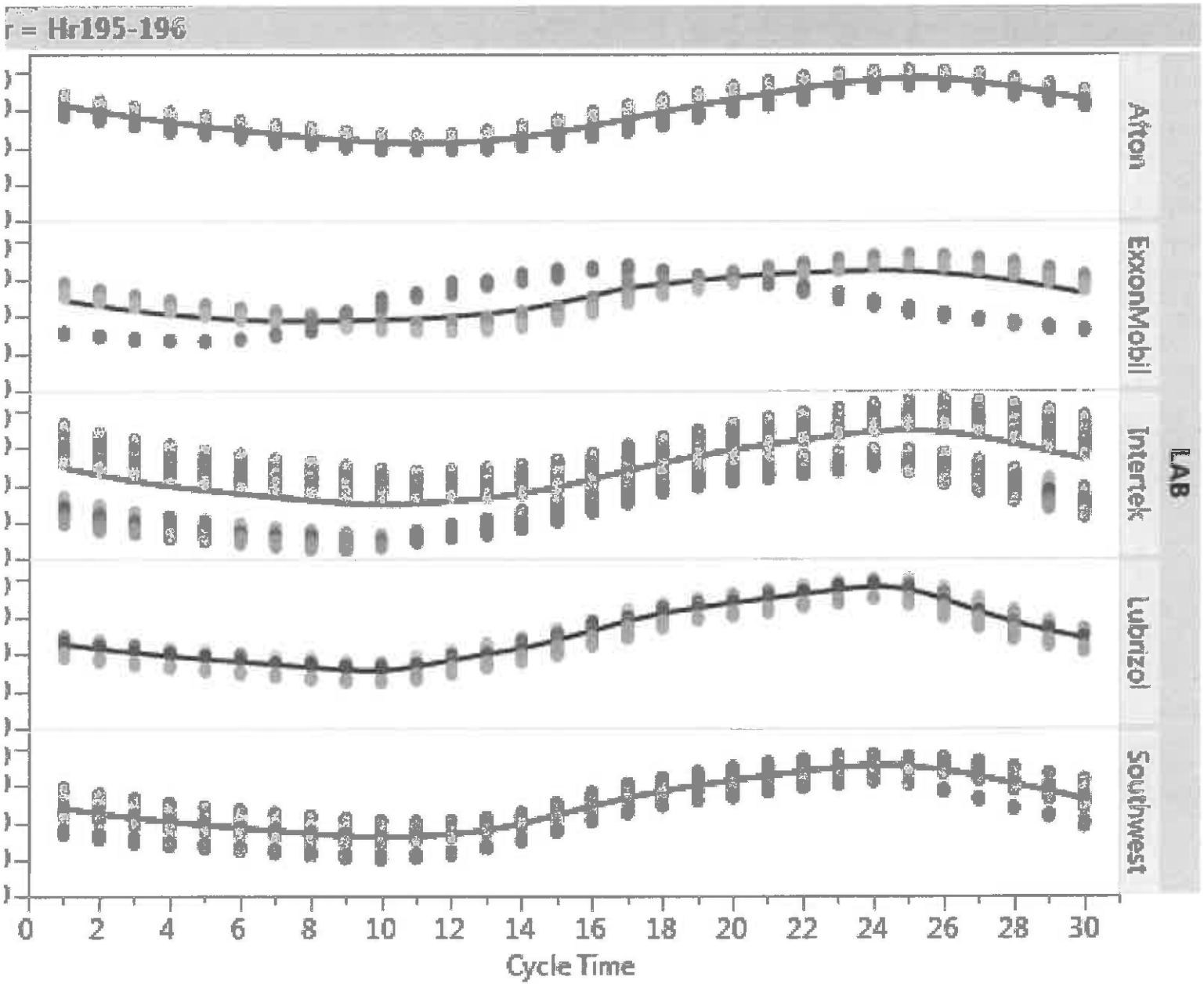
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Exhaust Gas Temperature vs. Cycle Time



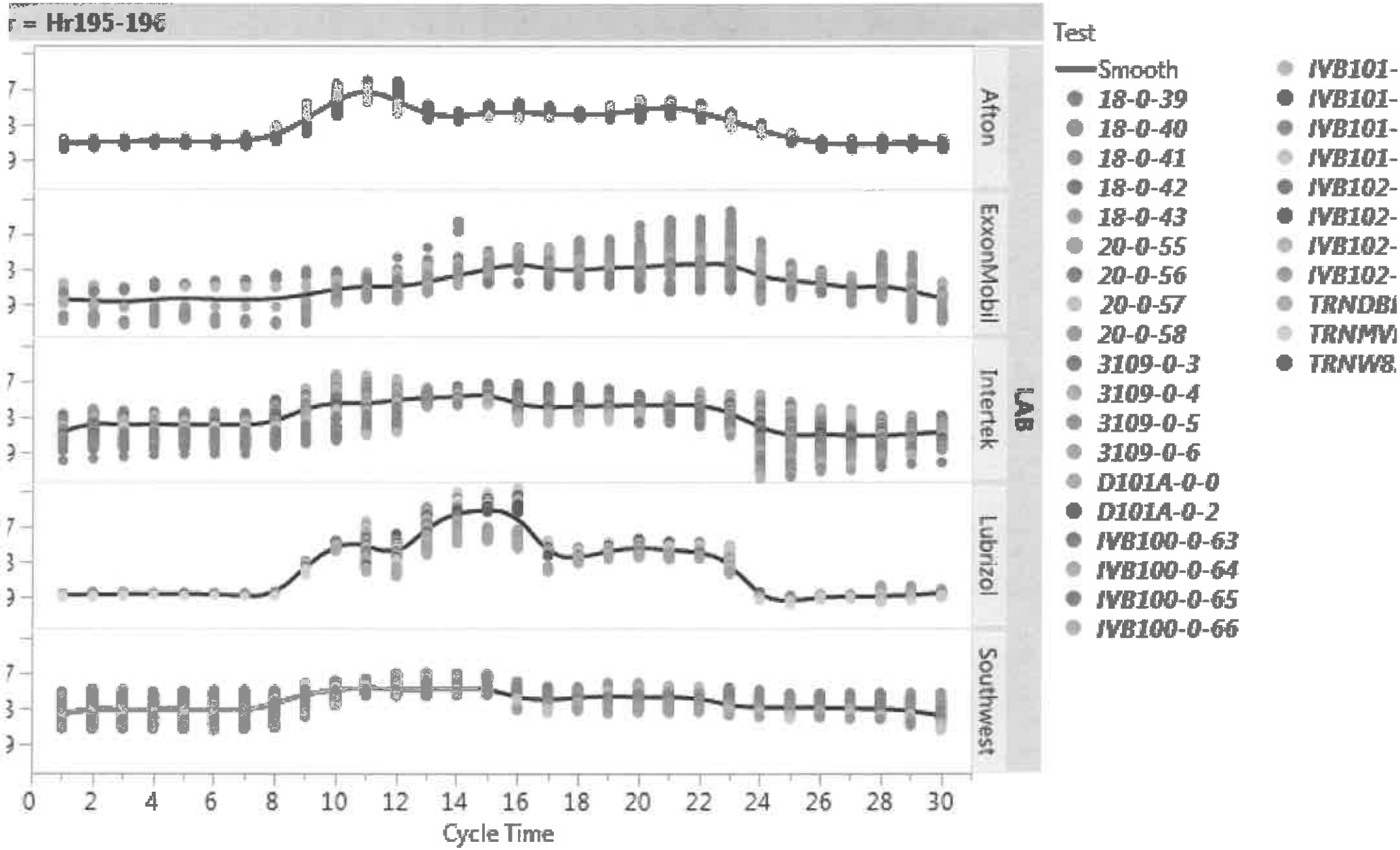
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

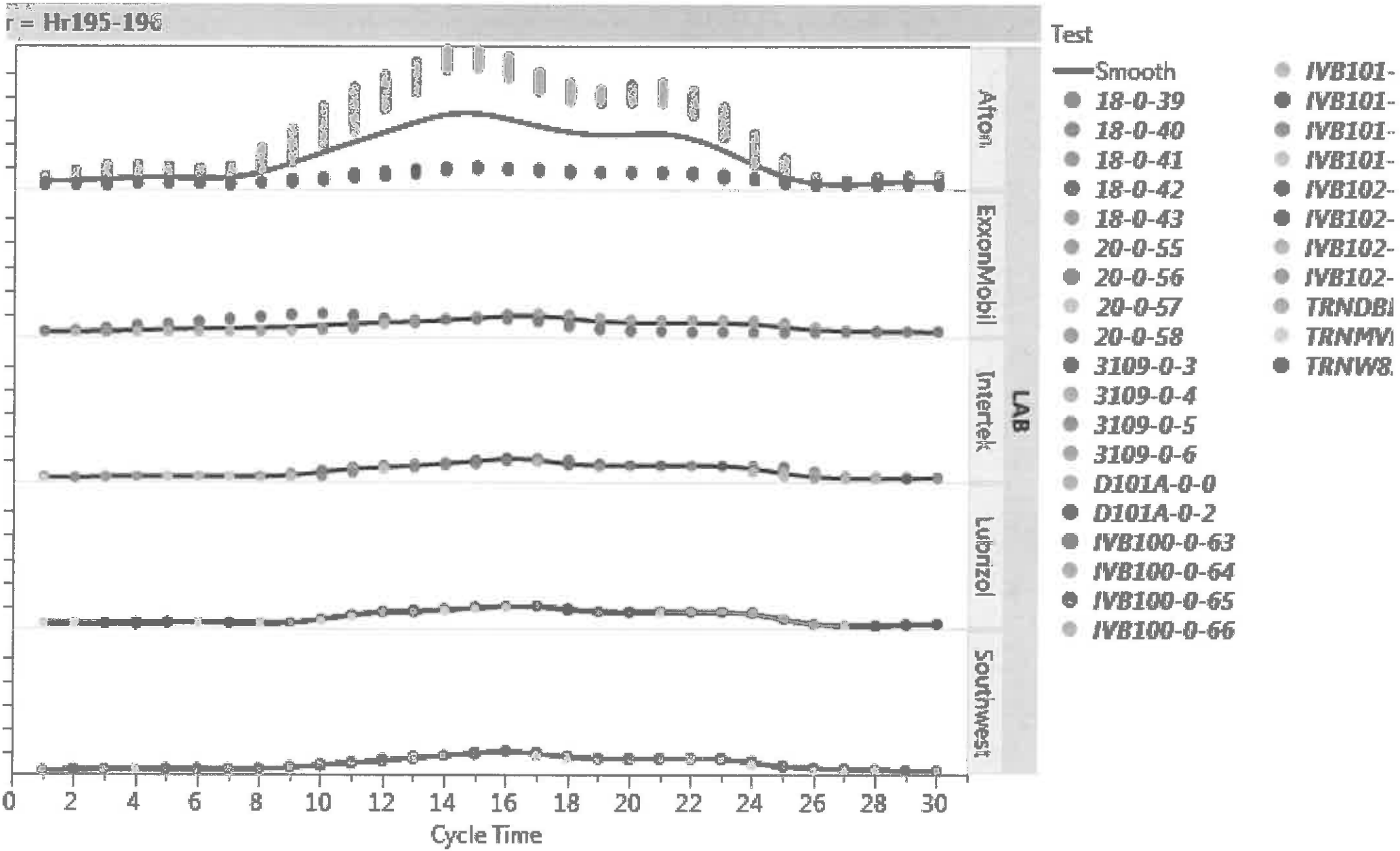
Exhaust Pressure vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Fuel Flow Rate vs. Cycle Time

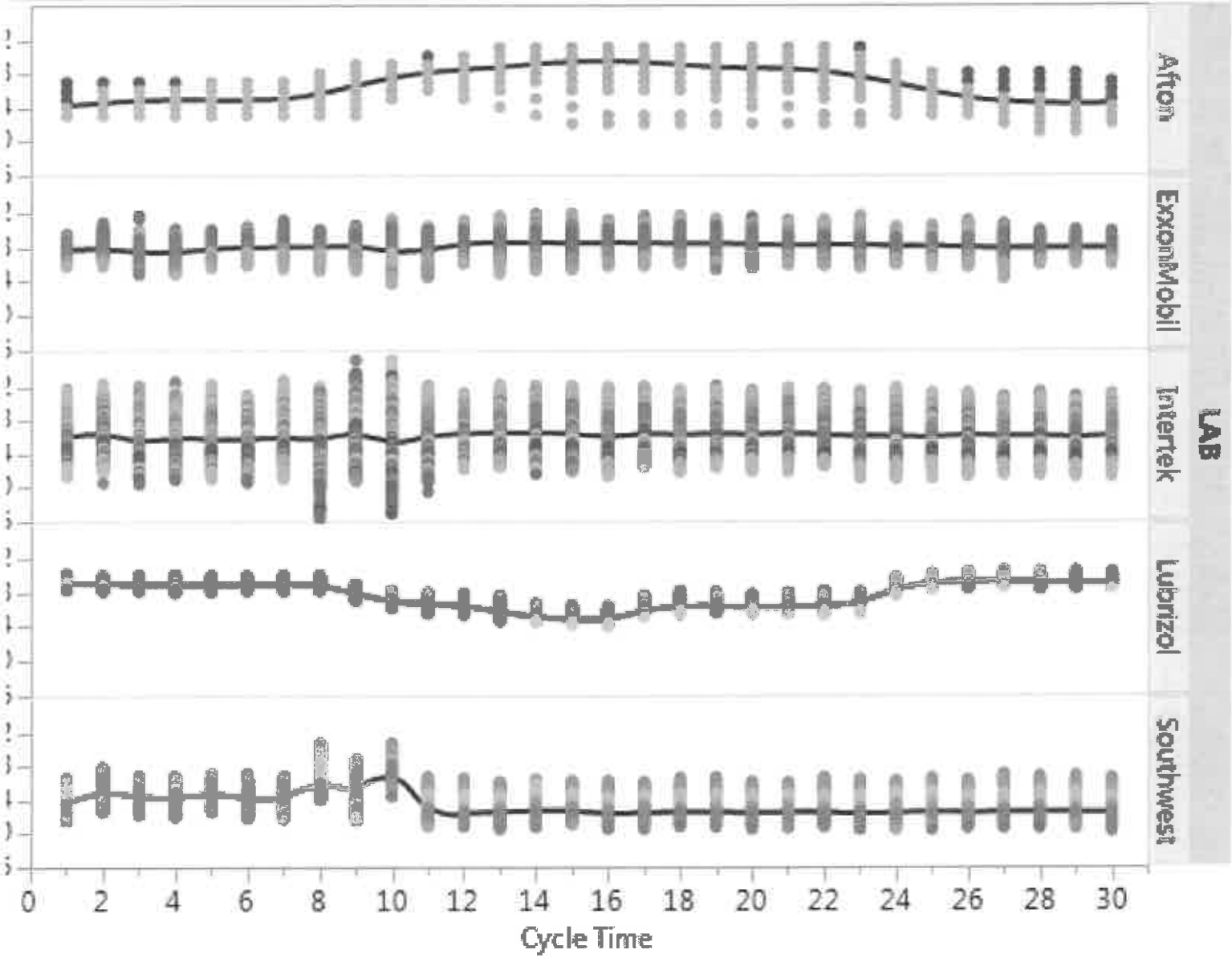


(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Fuel Rail Pressure vs. Cycle Time

r = Hr195-196



Test

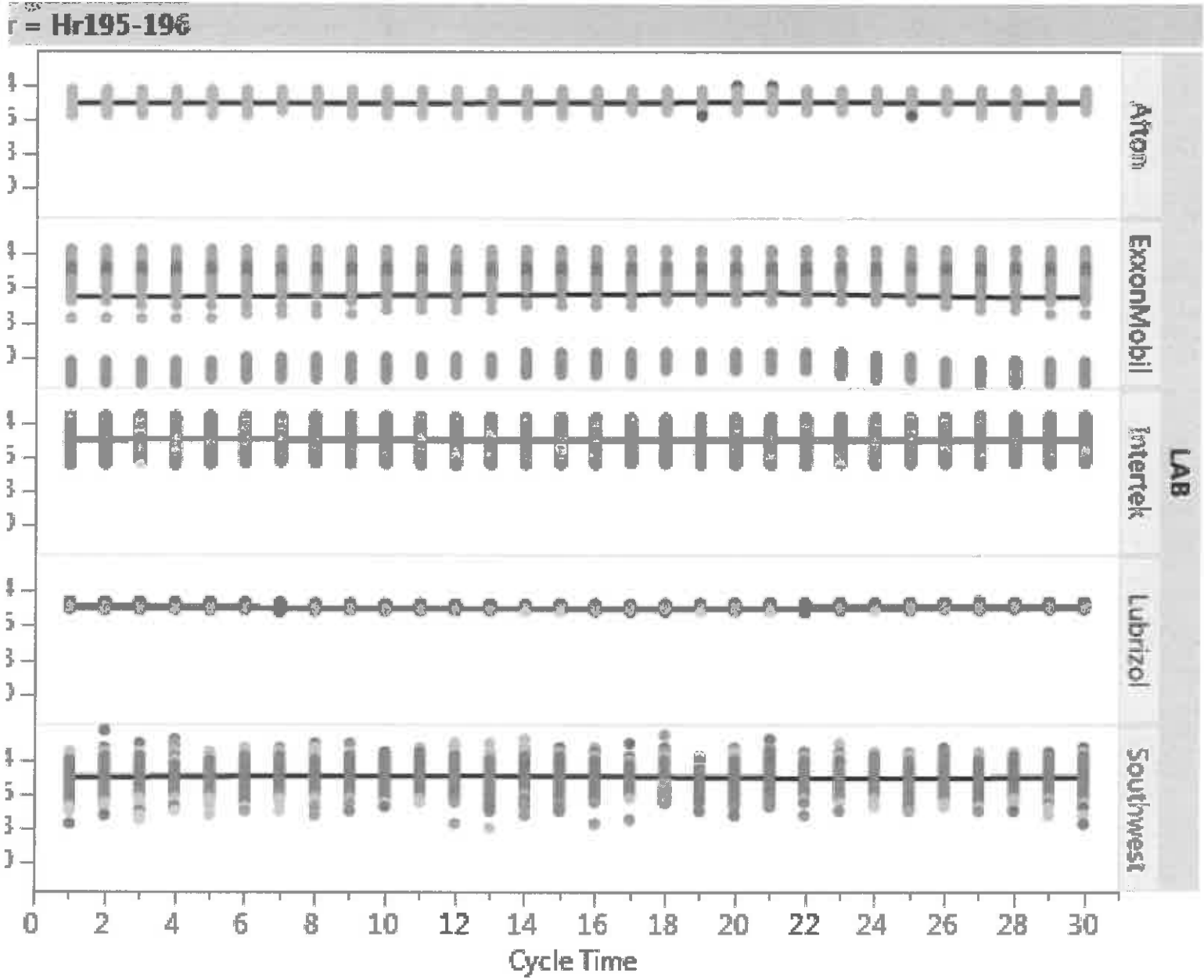
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Fuel Rail Temperature vs. Cycle Time

r = Hr195-196



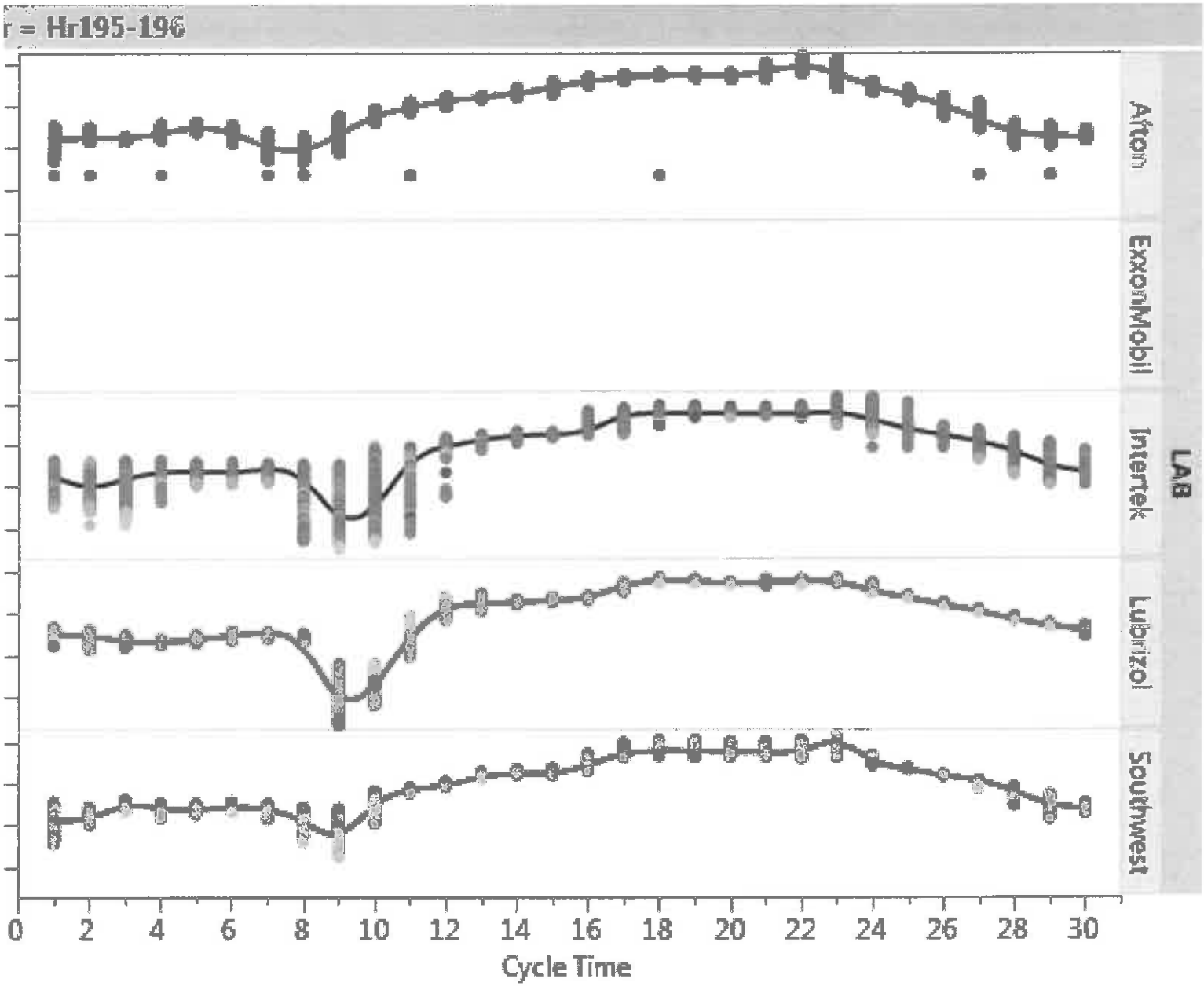
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Ignition Timing Advance vs. Cycle Time



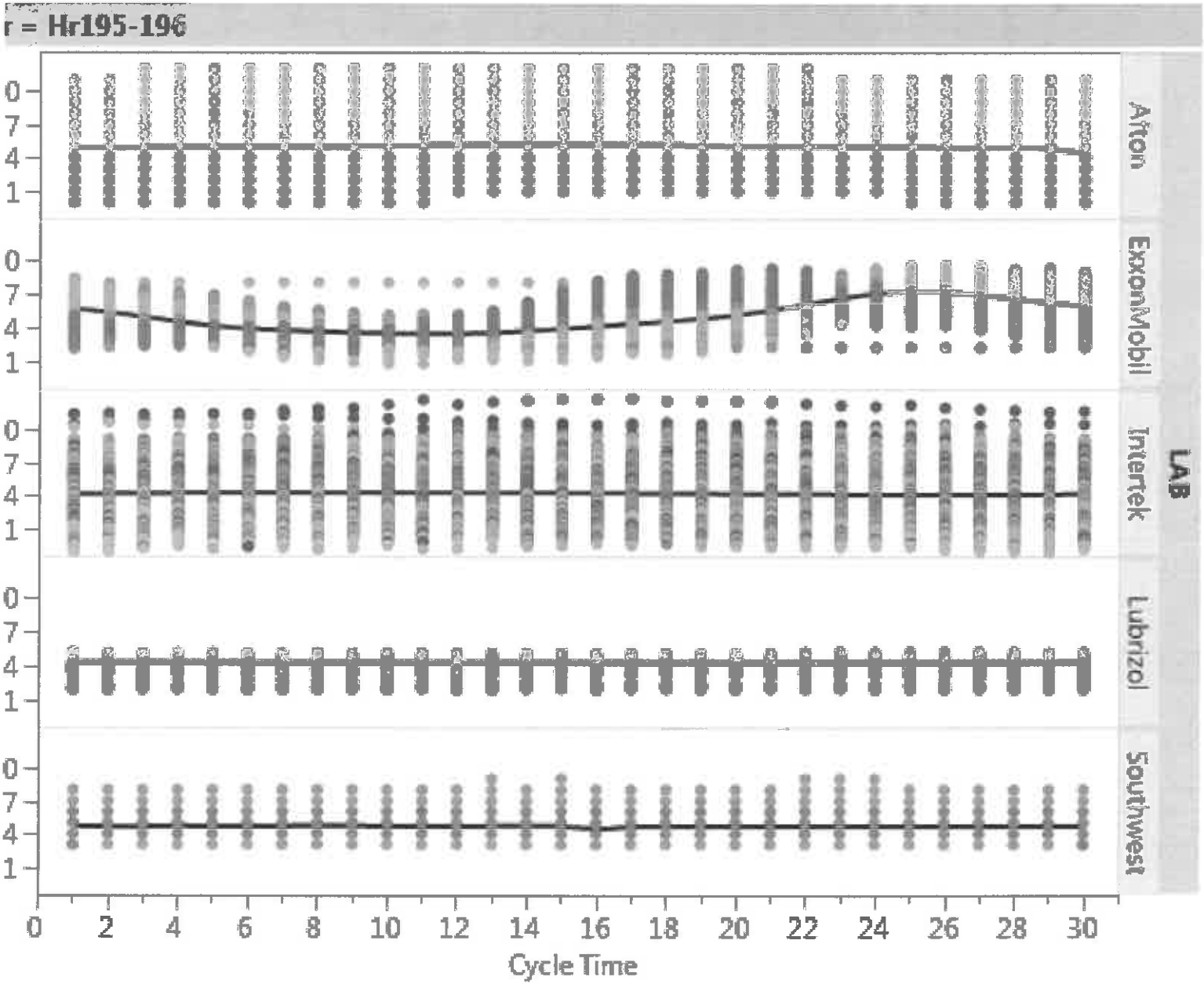
Test

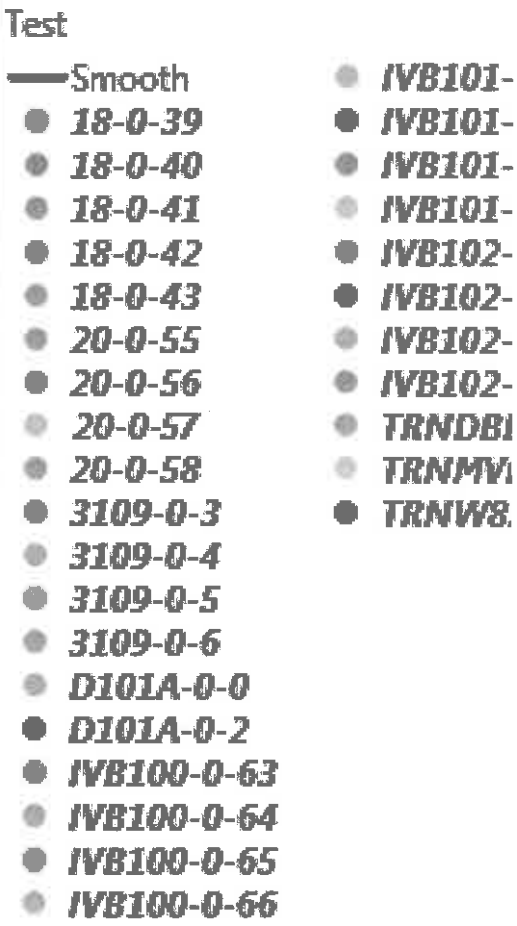
- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Air Humidity vs. Cycle Time



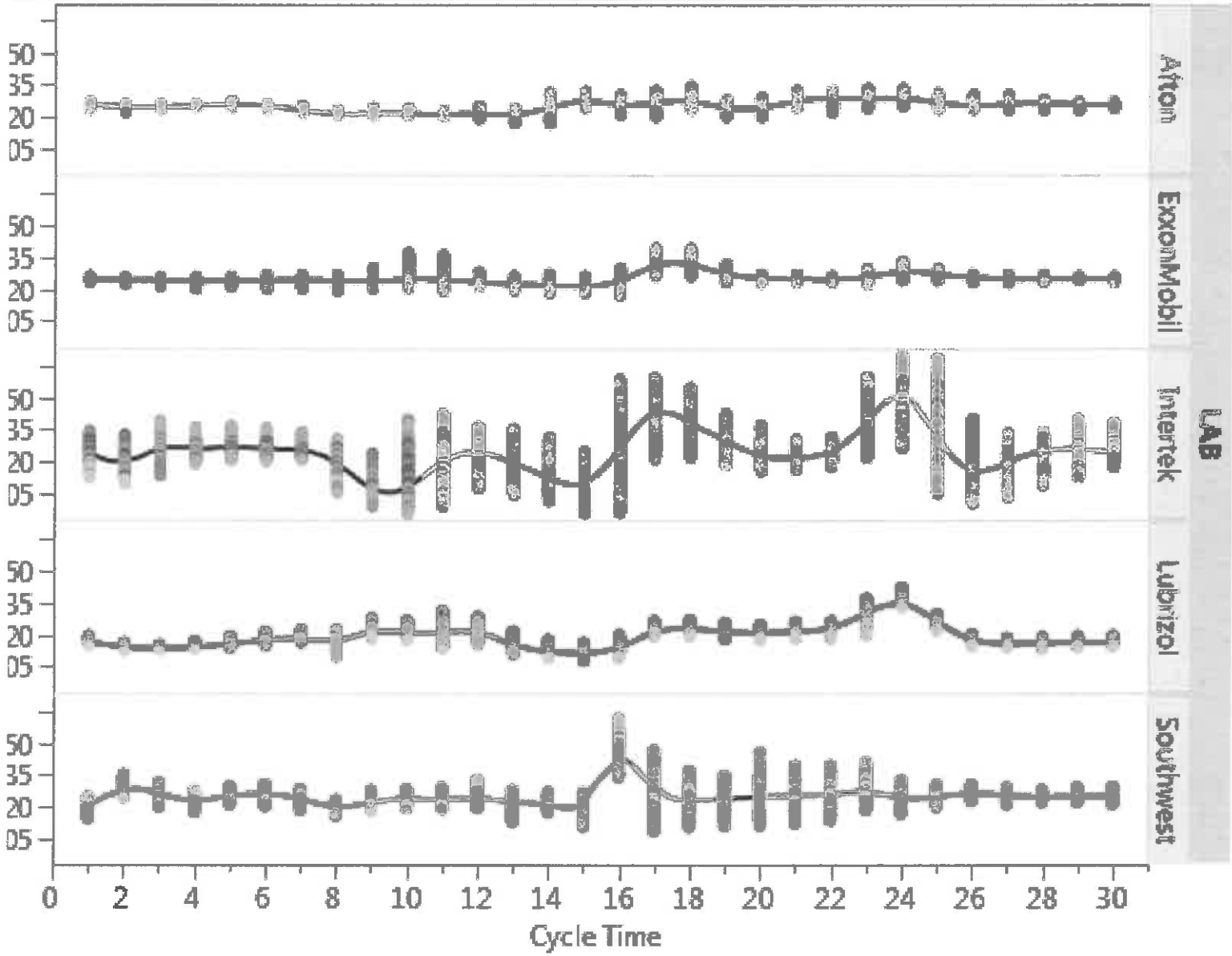


(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Air Presure vs. Cycle Time

r = Hr195-196



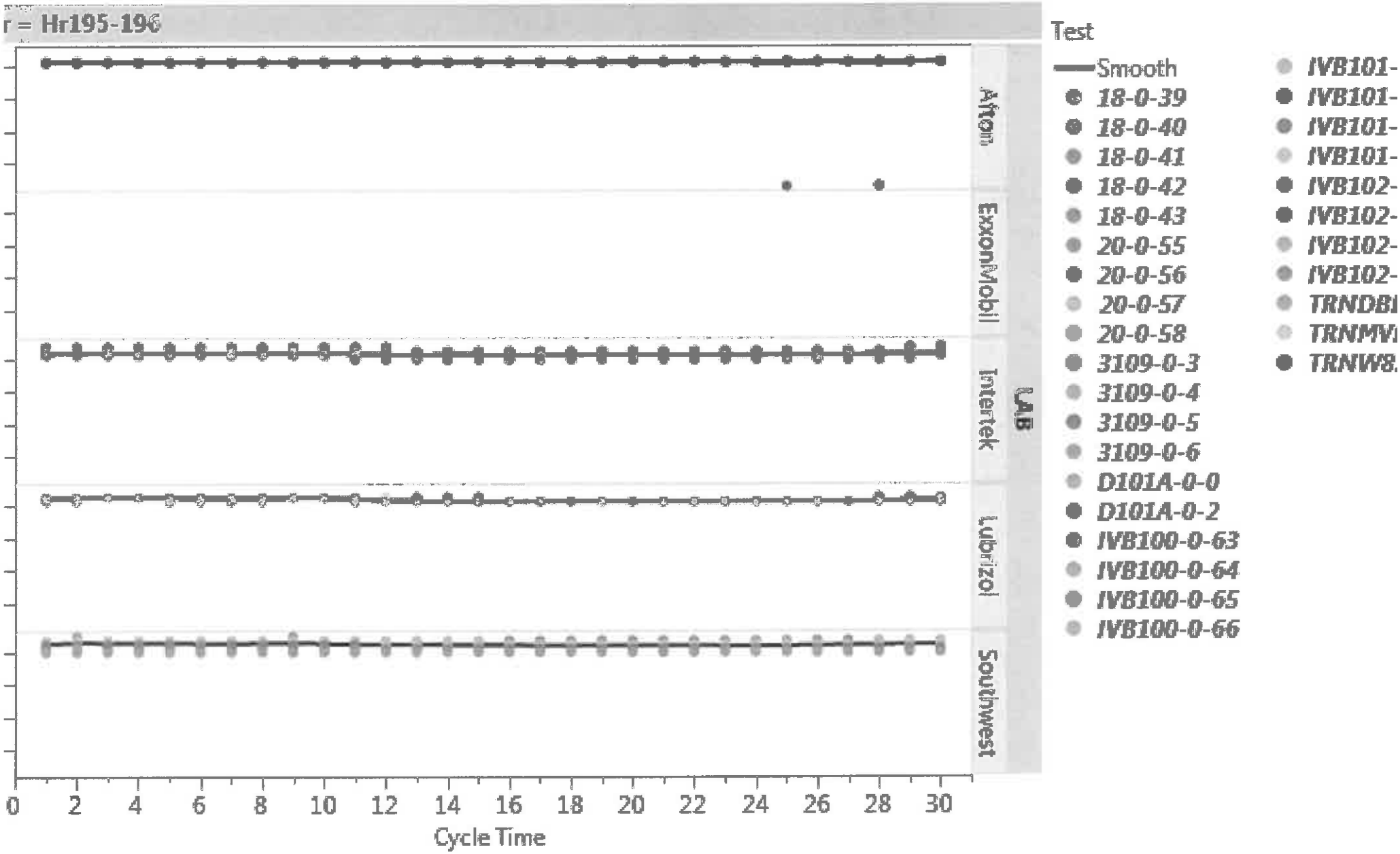
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

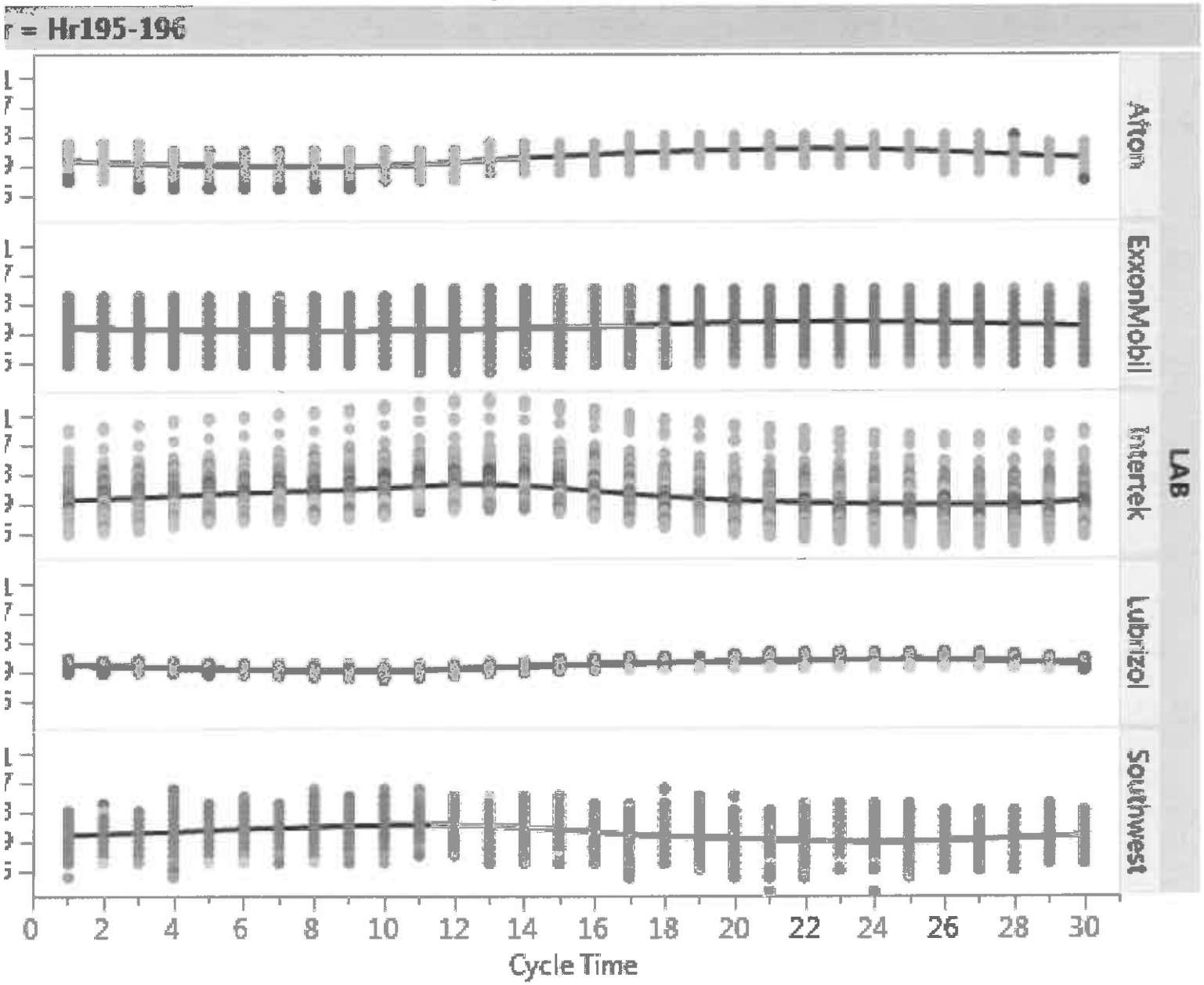
Intake Air Temperature 2 vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Intake Air Temperature vs. Cycle Time

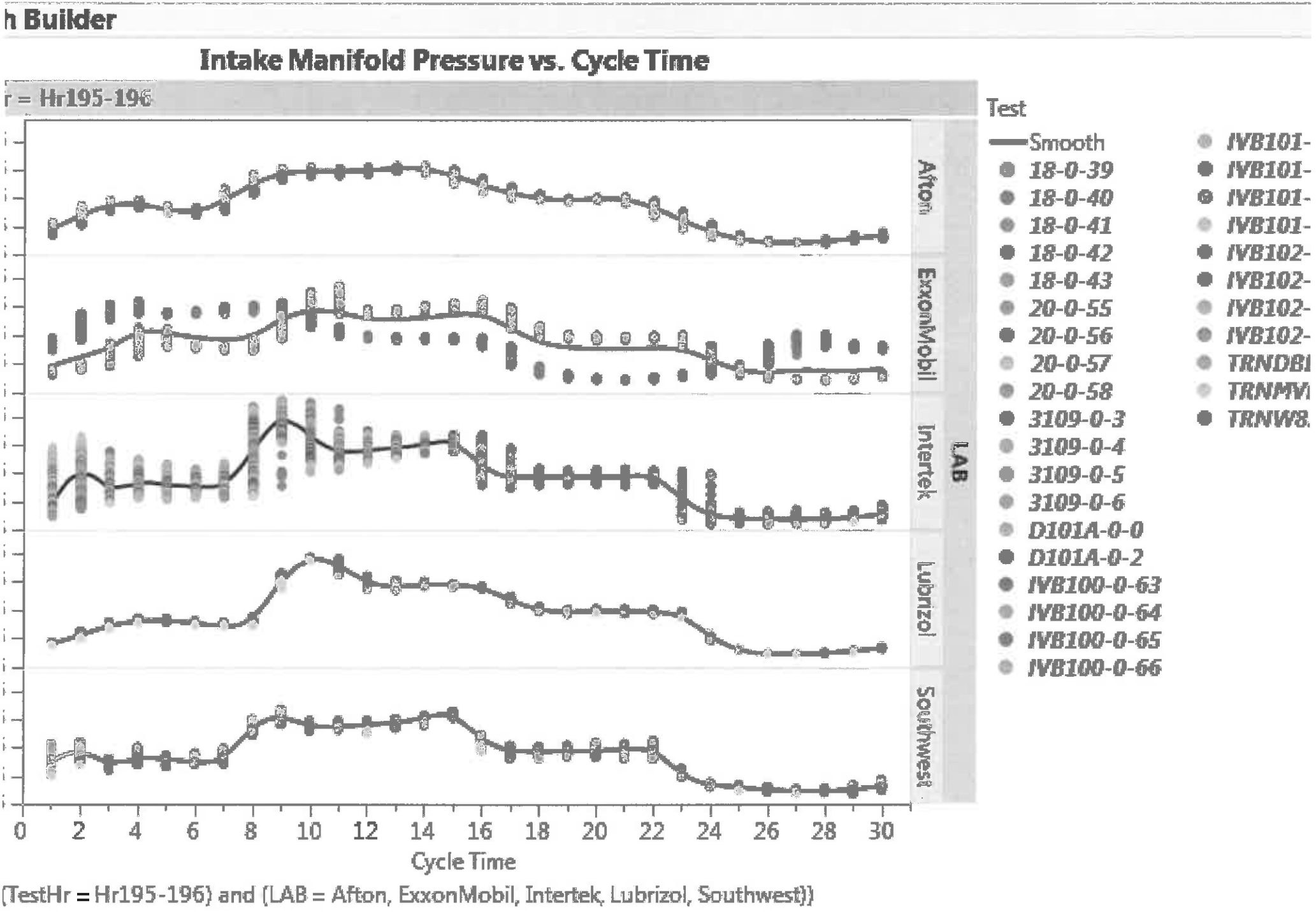


Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

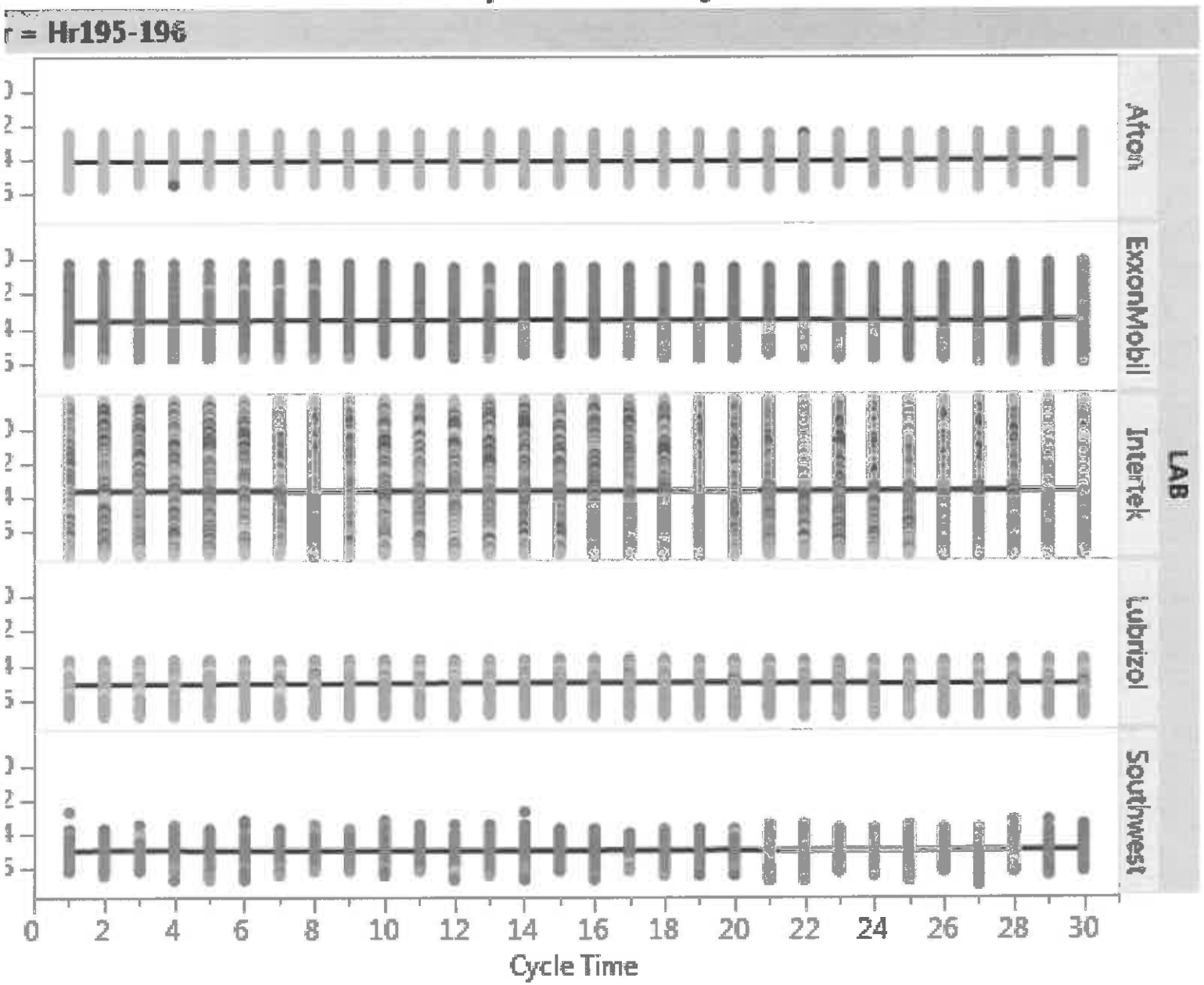
h Builder



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Load Cell Temperature vs. Cycle Time



Test

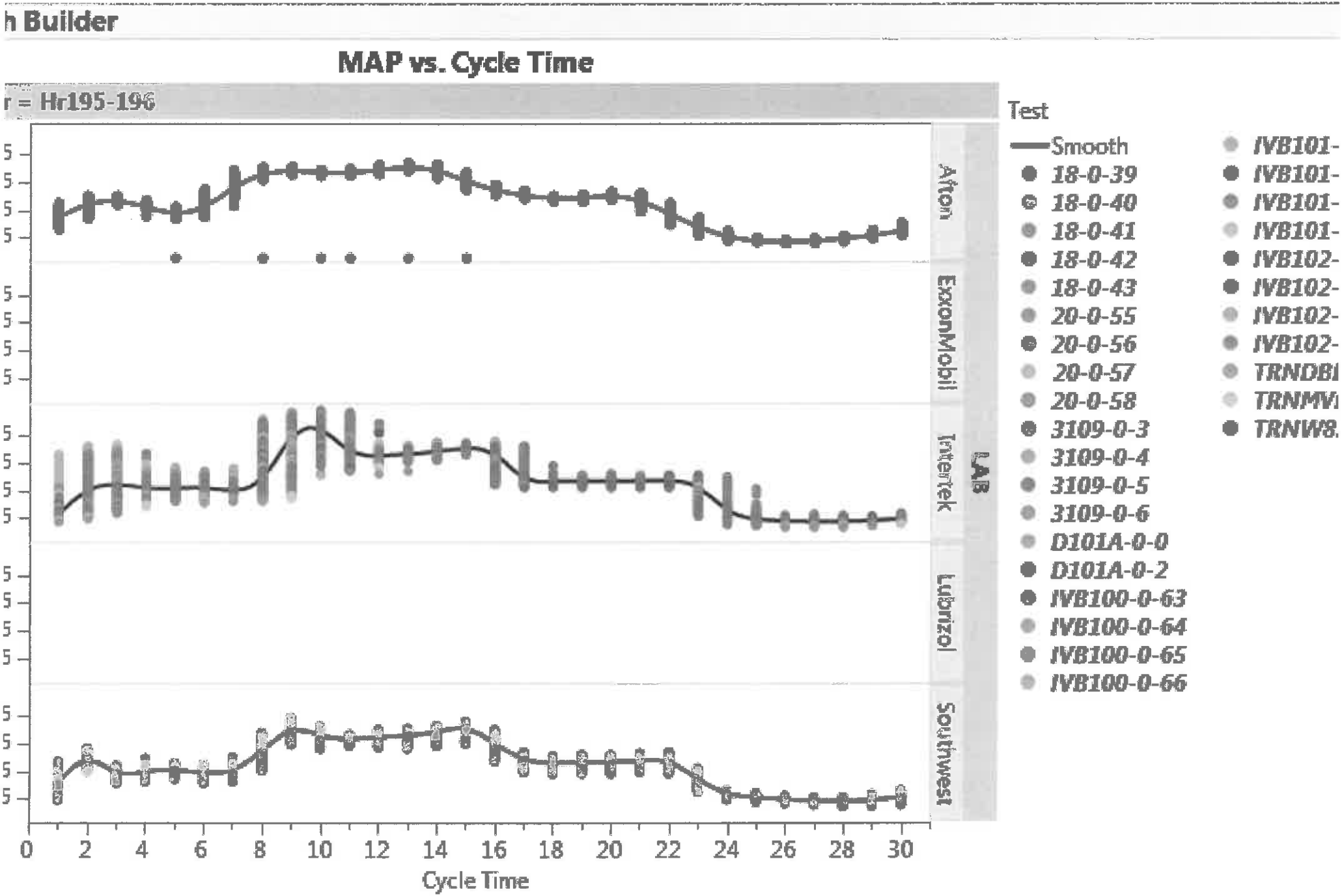
Smooth

18-0-39
18-0-40
18-0-41
18-0-42
18-0-43
20-0-55
20-0-56
20-0-57
20-0-58
3109-0-3
3109-0-4
3109-0-5
3109-0-6
D101A-0-0
D101A-0-2
IVB100-0-63
IVB100-0-64
IVB100-0-65
IVB100-0-66

IVB101-
IVB101-
IVB101-
IVB101-
IVB102-
IVB102-
IVB102-
IVB102-
TRNDBI
TRNMVI
TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

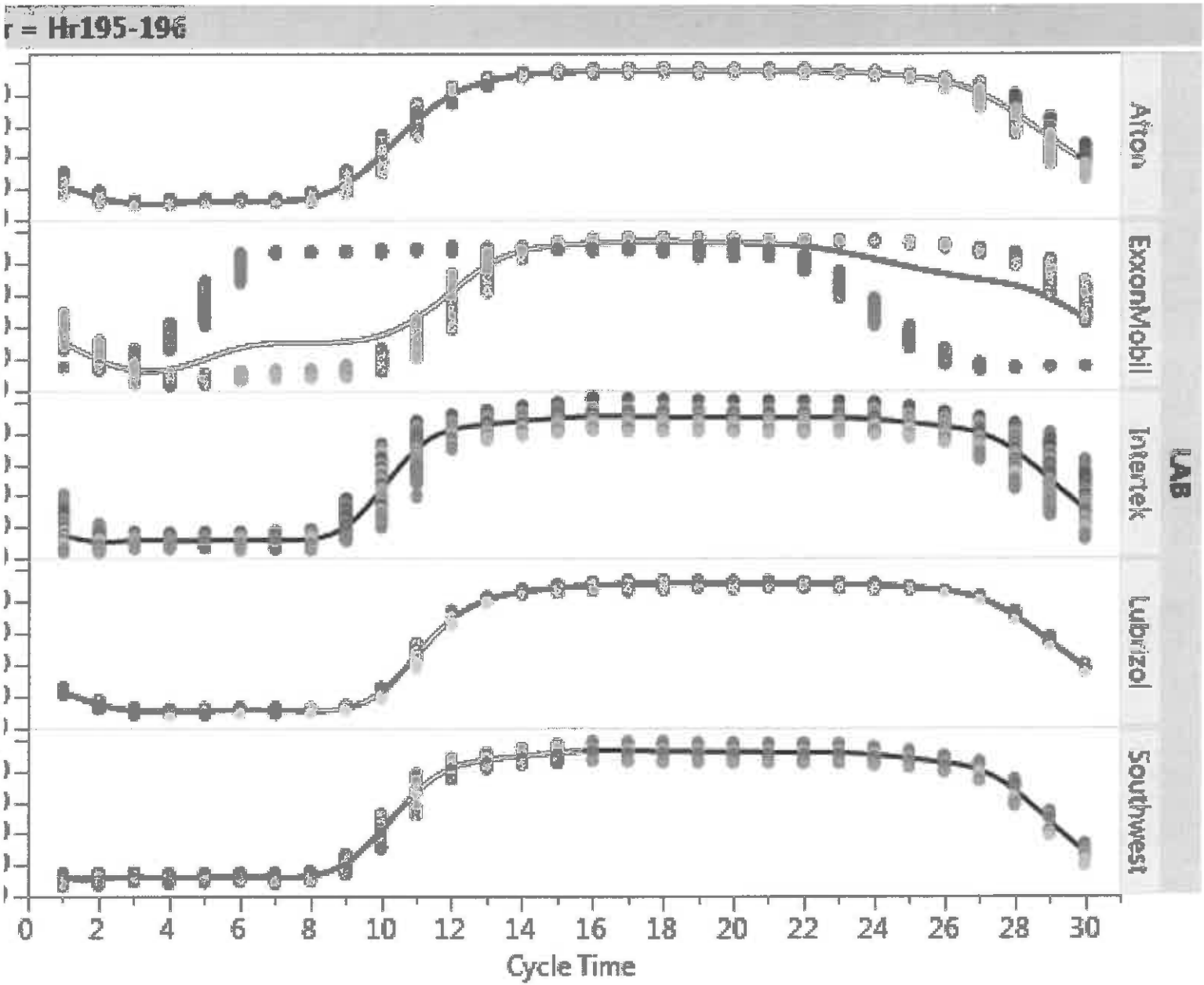
h Builder



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Oil Gallery Pressure vs. Cycle Time



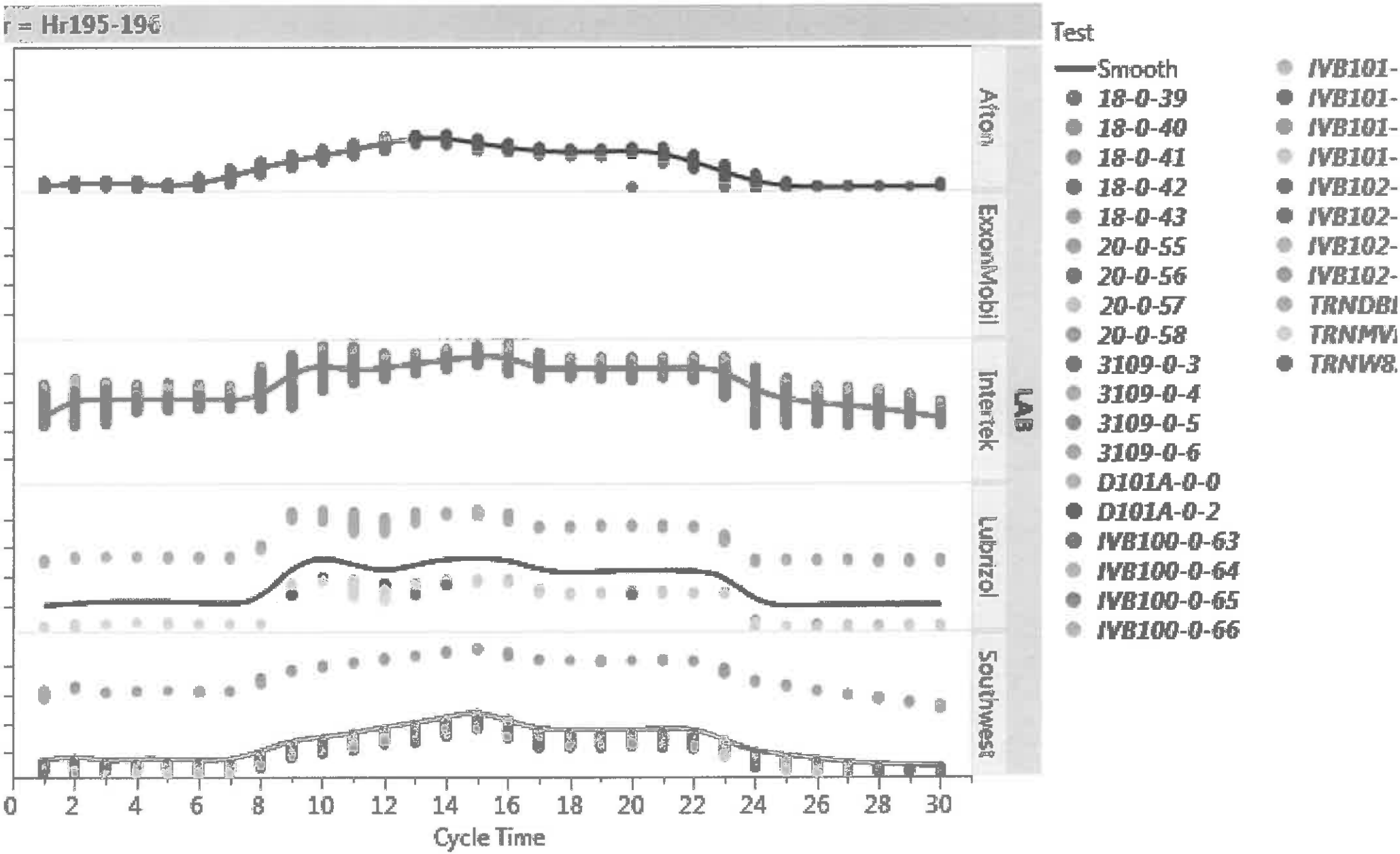
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

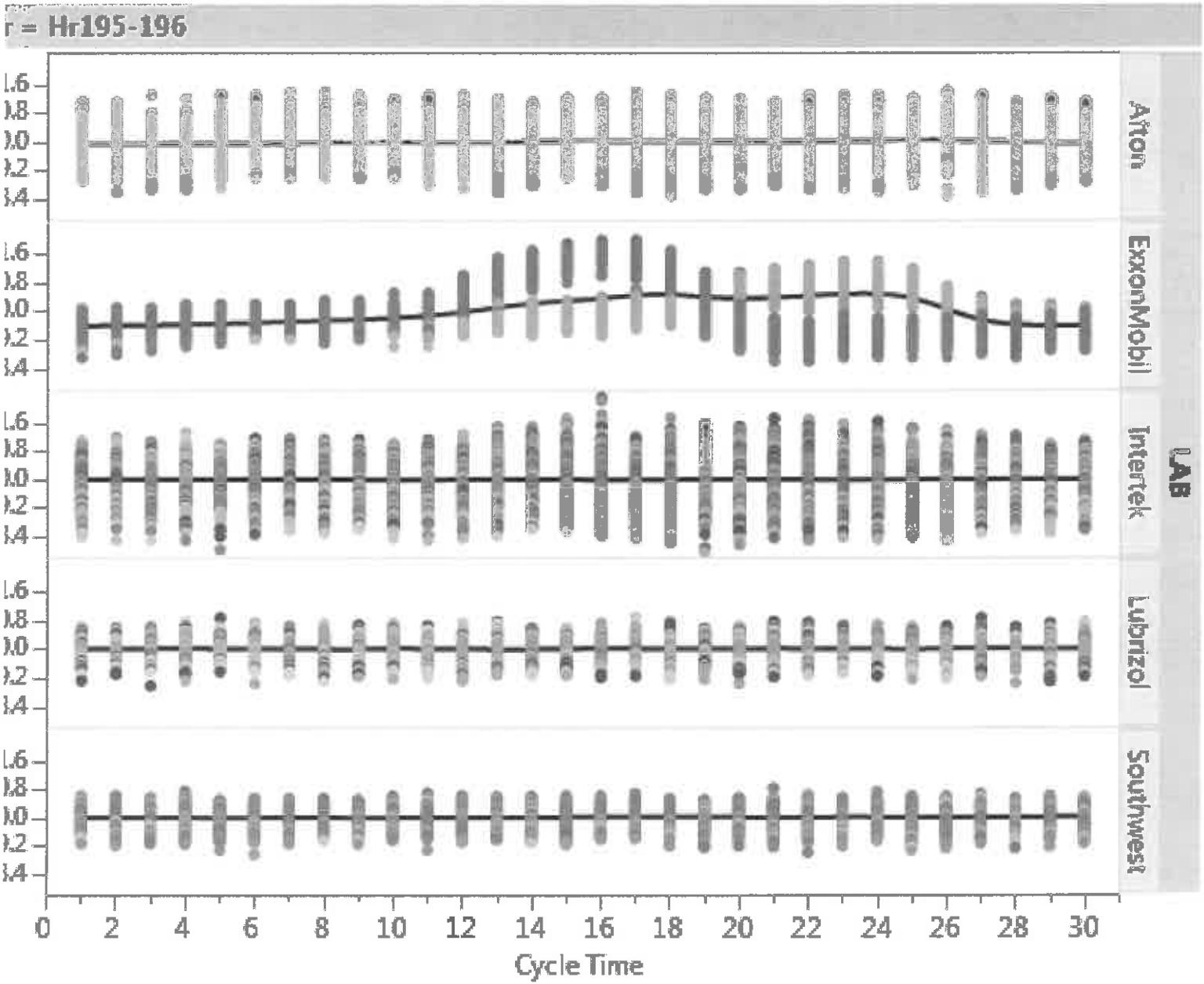
Pedal Position vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Rocker Cover Coolant Flow Rate vs. Cycle Time



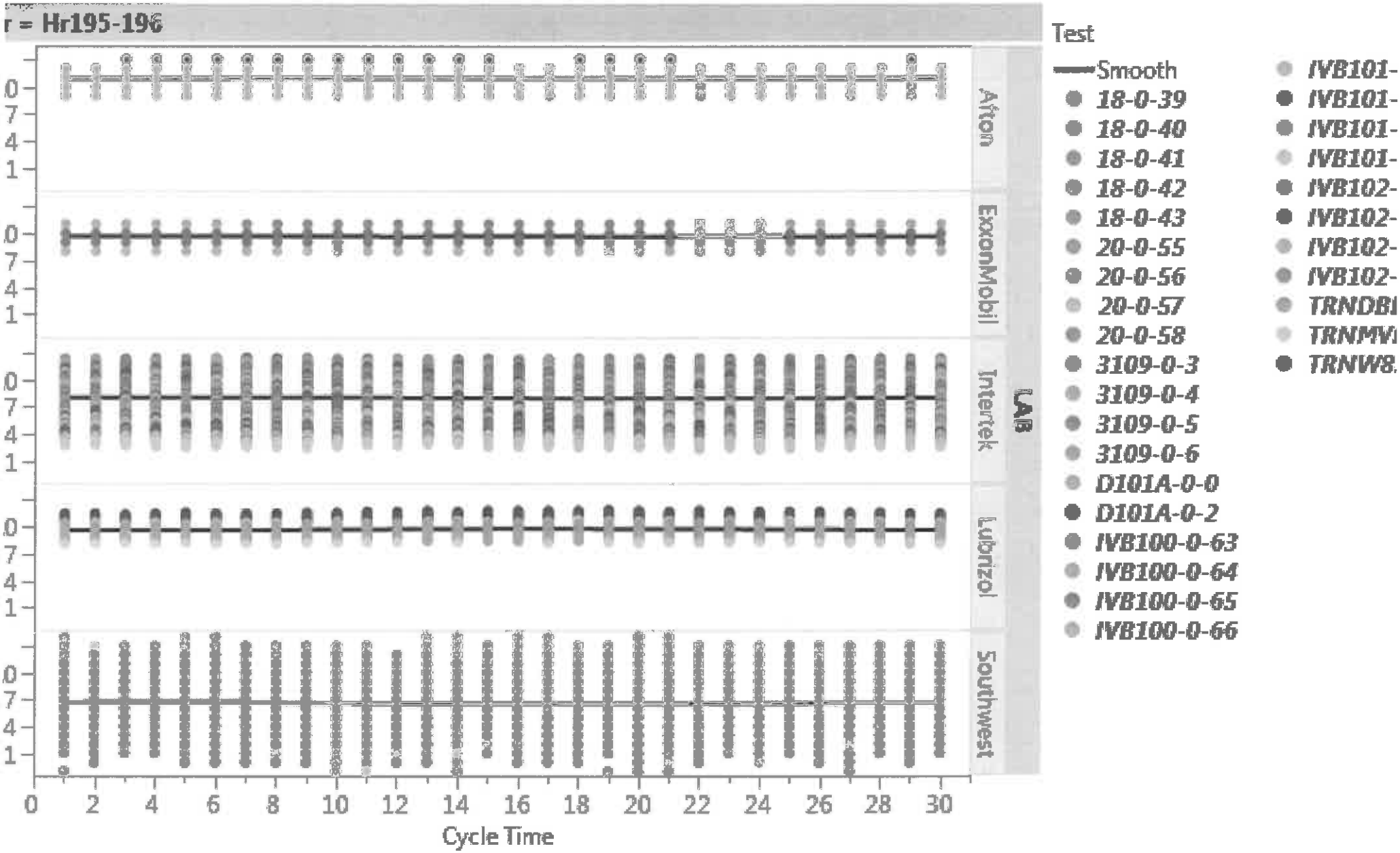
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

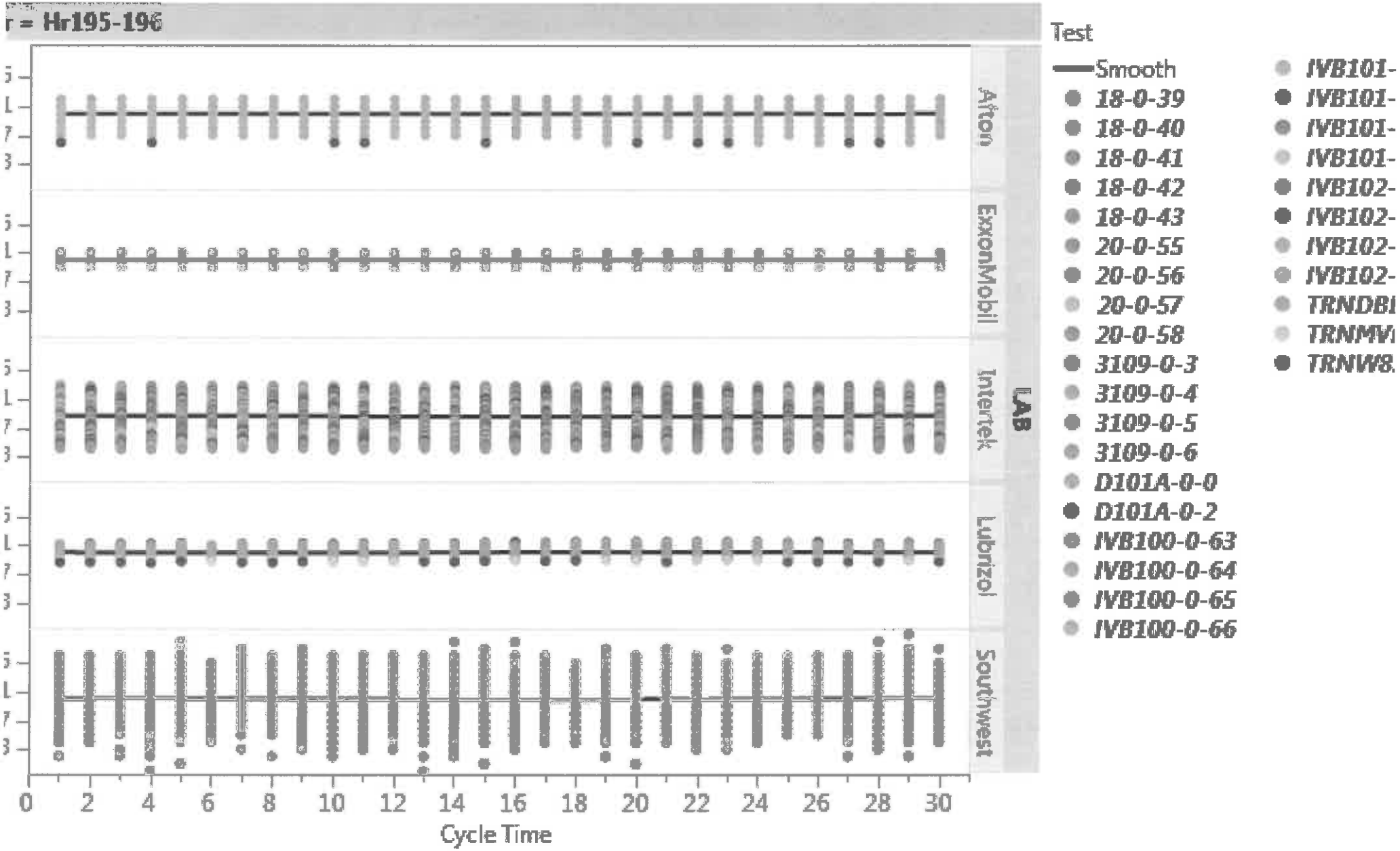
Rocker Cover Coolant In Temp. vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

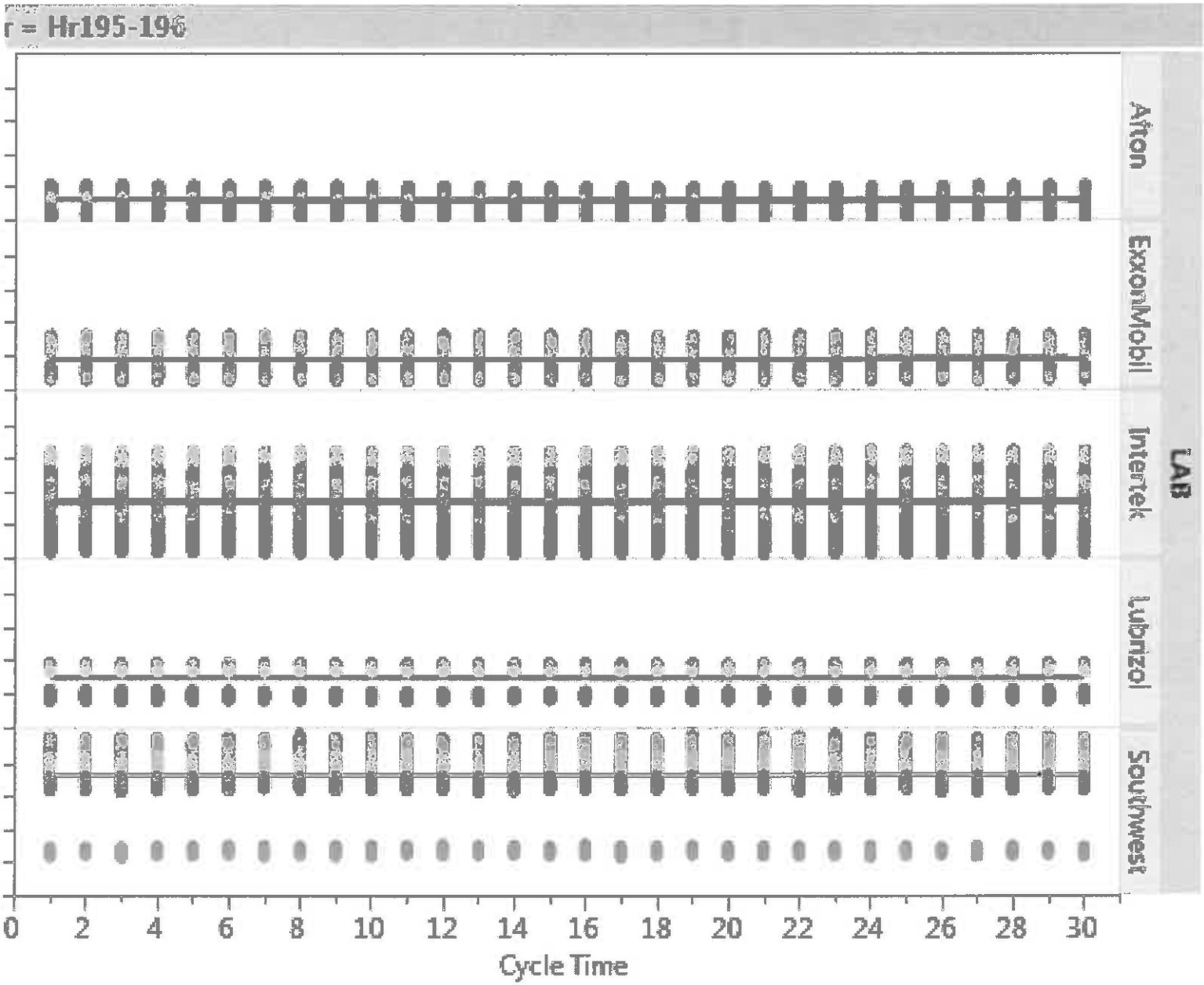
Rocker Cover Coolant Out Temp. vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Test Cell Air Temperature vs. Cycle Time



Test

Smooth

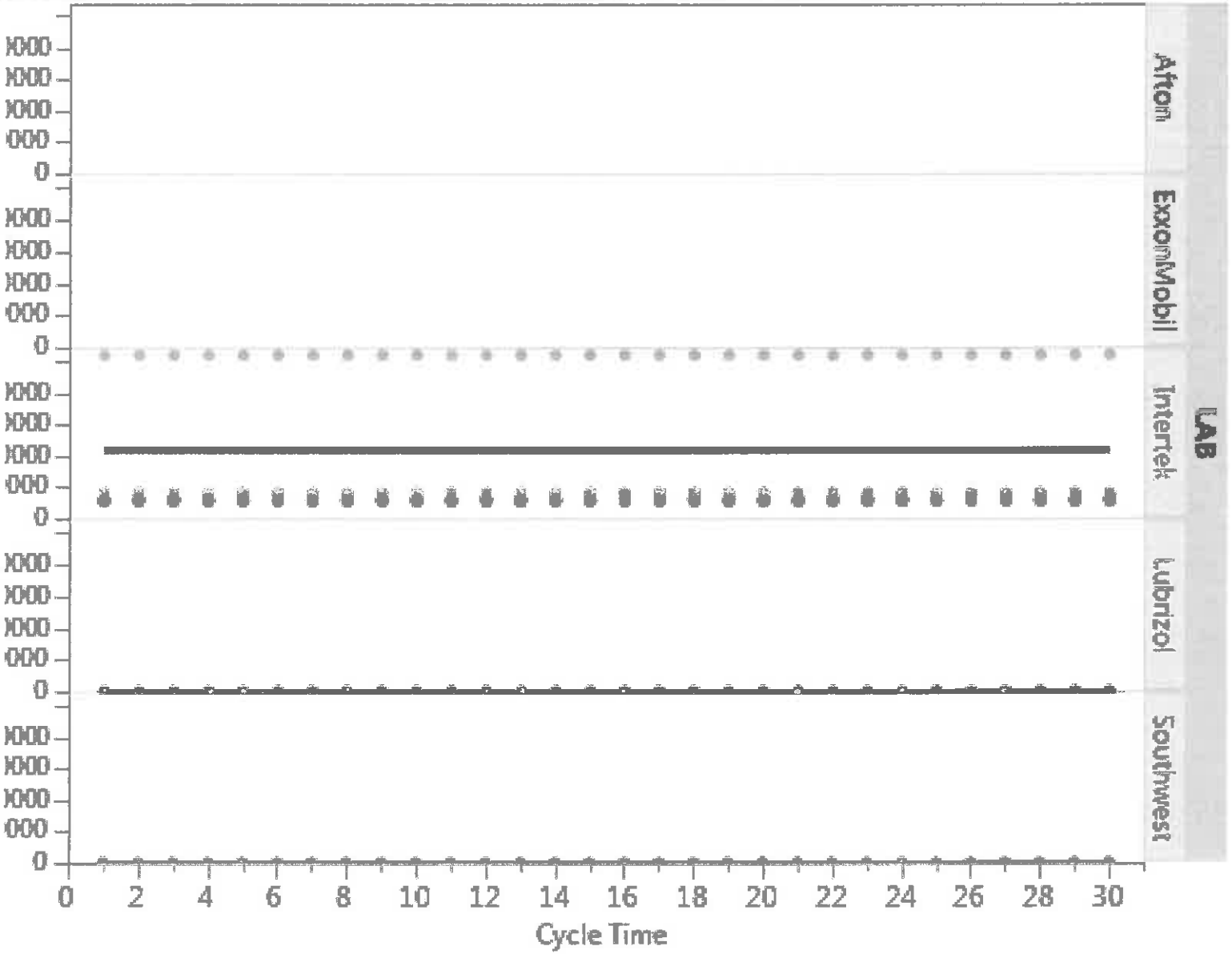
18-0-39
18-0-40
18-0-41
18-0-42
18-0-43
20-0-55
20-0-56
20-0-57
20-0-58
3109-0-3
3109-0-4
3109-0-5
3109-0-6
D101A-0-0
D101A-0-2
IVB100-0-63
IVB100-0-64
IVB100-0-65
IVB100-0-66
IVB101-
IVB101-
IVB101-
IVB101-
IVB102-
IVB102-
IVB102-
IVB102-
TRNDBI
TRNMVI
TRNW8

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Total Fuel Used vs. Cycle Time

r = Hr195-196



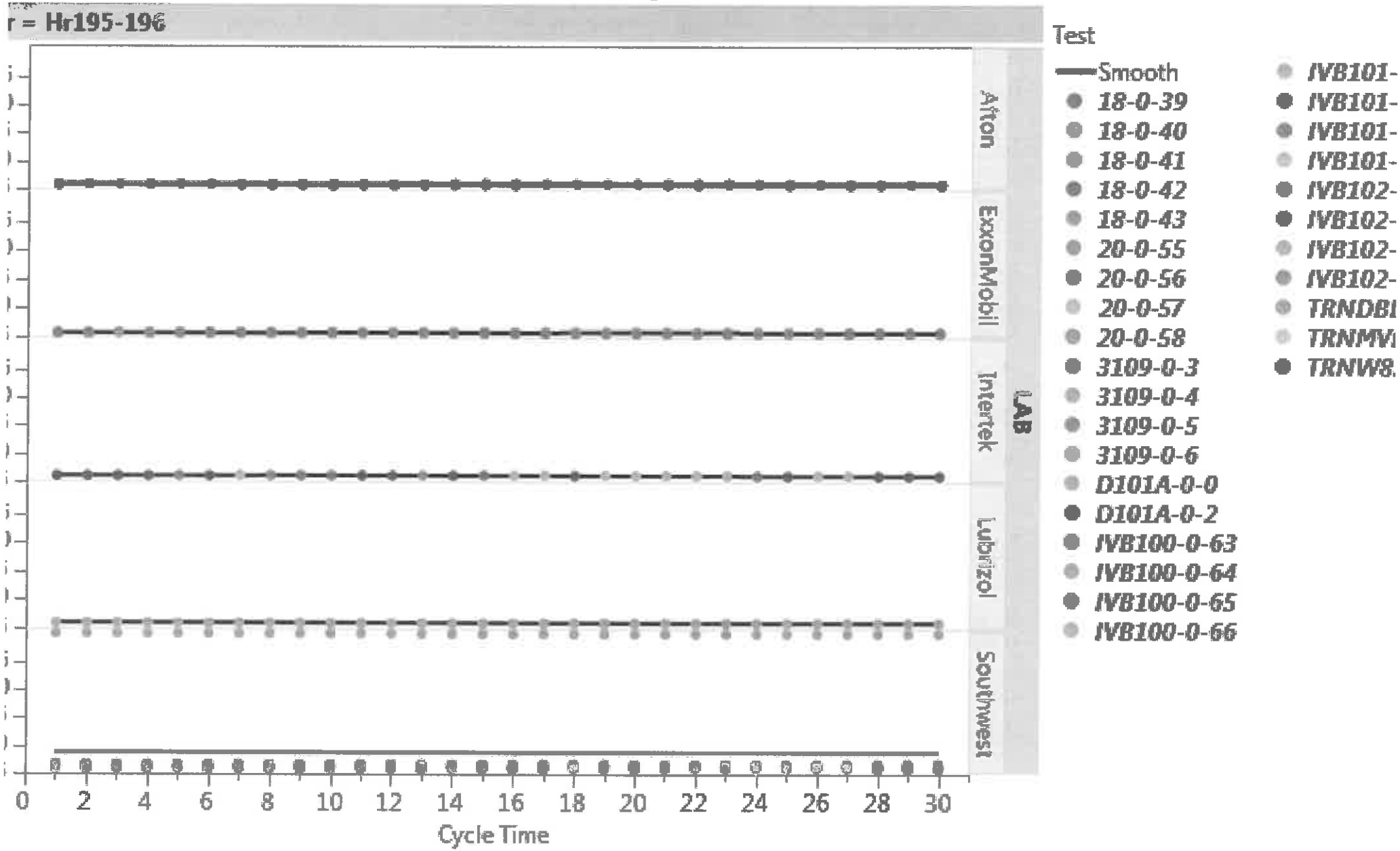
Test

- Smooth
- 18-0-39
- 18-0-40
- 18-0-41
- 18-0-42
- 18-0-43
- 20-0-55
- 20-0-56
- 20-0-57
- 20-0-58
- 3109-0-3
- 3109-0-4
- 3109-0-5
- 3109-0-6
- D101A-0-0
- D101A-0-2
- IVB100-0-63
- IVB100-0-64
- IVB100-0-65
- IVB100-0-66
- IVB101-
- IVB101-
- IVB101-
- IVB101-
- IVB102-
- IVB102-
- IVB102-
- IVB102-
- TRNDBI
- TRNMVI
- TRNW8.

(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

h Builder

Valve Cover Blowby Gas Out vs. Cycle Time



(TestHr = Hr195-196) and (LAB = Afton, ExxonMobil, Intertek, Lubrizol, Southwest))

Sequence IVB Operational Analysis

By: Industry Stats Team

02-14-18

)perational Analysis with Partial Least Squar

All operational data was analyzed using Partial Least Squares (PLS)

- Method is appropriate for multicollinear data and/or where the number of independent variables exceeds the number of observations
- Some operational, surface finish, and camshaft related variable measurement data analysis seems suspect (data entry error?), which will affect analysis results

Factors identified in partial least squares does not imply root cause

- It identifies factors that may be of interest for additional investigation

PLS Model Related info:

- Dependent variable analyzed: Sqrt(AVLI)
- Number of observations = 28
- Number of independent variables = 90
- For the analysis, missing values were imputed using mean value substitution

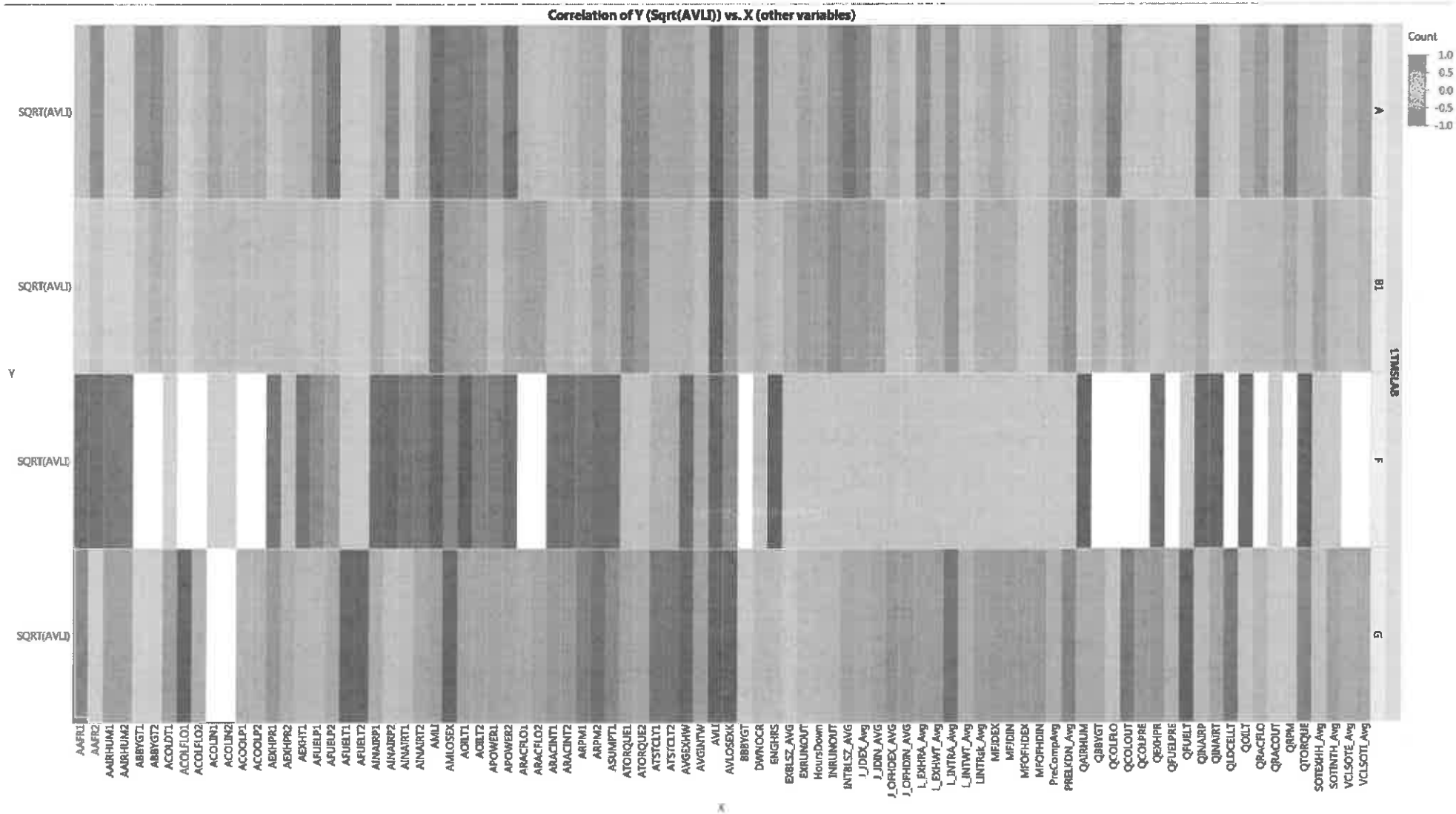
perational Analysis with Partial Least Square

Excluding lab-Stand & oil factors, the top 20 variables identified in th
nalysis of the Sqrt(AVLI) are summarized below:

	Top 20 Factors	Variable Description
1	INRUNOUT	Intake Camshasft Runout
2	L_INTRA_Avg	Lobe Intake Surface Finish Average Ra
3	EXRUNOUT	Exhaust Camshaft Runout
4	DWNOCR	Number of Downtime Occurrences
5	ARPM2	Average RPM - Phase 2
6	AAFR2	Avg Air/Fuel Ratio Phase 2
7	J_JDIN_AVG	Journal to Journal Dia Intake Avg
8	QOILT	EOT QI Oil Gallery Temp
9	PreCompAvg	Average Cyl Compression PreTest
10	EXBLSZ_AVG	Exhaust Lifter Bucket Size Average
11	J_JDEX_Avg	Journal to Journal Dia Exhaust Avg
12	ATORQUE1	Average Torque Phase 1
13	ACOOLP2	Average Engine Coolant Pressure Stage 2
14	ACOOLP1	Average Engine Coolant Pressure Stage 1
15	AFUELP2	Average Fuel Pressure Phase 2
16	SOTINTH_Avg	Start of Test Heel to Toe Intake Avg
17	MFJDEX	Main Feed Oil Hole Dia, Exhaust Cam
18	AINAIRT2	Avg Intake Air Temp Phase 2
19	QAIRHUM	EOT QI Intake Air Humidity
20	INTBLSZ_AVG	Avg Intake Bucket Lifter Size

perational Analysis with Partial Least Square

A color heat map of the correlations between the Sqrt(AVLI) and the emaining variables are summarized below - by test lab:



perational Analysis with Partial Least Square

lots of all variables included in the analysis are provided in the follov
ides.